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JUNIOR COLLEGES

By WALTER B. JONES

University of Pittsburgh, Chairman S. P. E. E. Committee

Engineering schools have been made aware of the tremendous growth of the junior college, if in no other way than by the increasing number of transfer students knocking at their doors.

The papers read at the Corvallis meeting attest to the need for trained men in the middle level occupations, ranging in number from three to five of the latter to each professional engineer.

The engineering profession up-to-date has been inclined to treat training programs of less than the sacred four years of college with considerable indifference. This is indicated in part by insistence on labeling of shorter courses by such terms as semi-professional, non-degree, and others implying incomplete training. Such titles tend to damn the program from the beginning and both students and faculty are quick to see the implication. Fortunately, a changing attitude is developing in the direction of recognizing the place and function of so-called terminal courses.

Difficulties of educational organization and administration will submit in time to solution under able leadership. But out of the experience of the past it seems clear that if training programs of middle-level or terminal character are to thrive on the same campus with senior college preparatory courses, the former must not be dominated by the preparatory or other groups with different objectives and made to feel inferior because their course terminates in less than four years. The test of a successful program should be, does it fit the individual and at the same time provide competence in an occupation? The test should not be, is it equal to or a duplicate of some other course?

Experience seems to indicate the advisability either of a separate training school for terminal courses or to provide such courses only in schools where there is sufficient demand for this type of training so that the group would be large enough to develop group consciousness. Perhaps this is the secret of the success of such experiments as some of those in the junior colleges on the west coast where eighty per cent of the enrollment is in terminal courses and the remainder in courses preparatory to senior colleges; and, conversely, it may be the reason why comparative failure has attended the training of the middle level group in junior institutions where

the senior college preparatory enrollment predominates. This may also be the reason why the separate technical institutes have been successful while similar courses in four year engineering schools have been failures.

Whatever may be the solution to the problem, and it will be a different one in different communities, the transfer student from the junior college will present himself for admission to the four year institution. He will have preparation either in engineering school preparatory courses or in terminal courses, and it seems reasonable that those from the two groups who would profit by continued training should not be denied consideration.

If junior colleges cannot provide adequate introductory training for prospective engineers, obviously engineering schools should demand that all four years be spent on the latter's campus. However, if the junior college prepares for the senior college, it is not impossible to suppose that, at least in the larger centers, as adequate preparatory training could be provided for prospective engineers as for other students. Some institutions have met the problem of coöordinating the work of junior and senior college by forming a liaison with junior colleges in their state, as is eminently true in Minnesota and Kansas, or by establishing junior colleges under their own direction in off-campus centers as at Pittsburgh.

In justice to the students of superior ability, wherever they are trained, it would seem that provision should be made either for institutional accreditation by subjects or provision for individual accreditation through examination. Where competence is found, credit should be allowed.

It is to the latter problem of transfer credits and their evaluation that the Junior College Committee of the Society for the Promotion of Engineering Education is this year directing its attention. It is hoped that this problem can be studied dispassionately but with courage to demand justice for thorough training however or wherever obtained.

INSTRUCTION IN INDUSTRIAL RELATIONS ON THE PACIFIC COAST *

By CHARLES DERLETH, Jr.

Dean, College of Engineering, University of California

A glance at the S. P. E. E. Journal of Engineering Education shows that there are at least two subjects of unusually live interest to our members. One is engineering instruction in Management, Business and Industrial Relations. The other is English for Engineers.

I will not decide which subject seems more inviting to our authors. Questionnaires reach me equally and frequently in both departments of inquiry. Engineering faculties feel the urge which comes from industry and society demanding improvement in engineering education and closer attention by teacher and student to training in social relations and language.

May I be so bold to digress here a moment to say this: Last night we heard an illuminating speech from the President of the Massachusetts Institute of Technology. He proved to us that there are cultural aspects in our engineering atmosphere. But why should we be on the defensive. Why should we imply an inferiority complex in subjects which relate to physics, language and cultures?

I have been asked to report on the present status of instruction in Industrial Relations on the Pacific Coast. I have addressed the Engineering Colleges of the Pacific Coast States west of the Rocky Mountains. The officers of these institutions have generously replied. It is clear that all of them are striving to insert social and language courses into their curricula, even at the expense of technical fundamentals and basic subjects in pure science. In closing I shall list a summary of Pacific Coast offerings to engineering students, but first I desire to give my views of a trend toward undue emphasis upon accomplishments which after all are largely the result of native talent and years of experience in men of capacity and personality who teach themselves gradually how to manage men.

To demand of all students who enter our engineering colleges continued training in linguistics, economics and industrial relations is a waste of time—an effort to do the impossible. Yesterday a clear distinction was made between the problems of the technical

* Presented at the 40th annual meeting S. P. E. E., Corvallis, Ore., June 29–July 1, 1932.

institute and those of higher engineering organizations which lead to graduate instruction and research. Our engineering schools, it seems to me, are grappling with difficult problems due to the mixture, on the same campus, in the same courses under the same faculty, of two types of students: those who possess the possibilities for the highest reaches of the profession, and those who are to act as the assistants. By mixing these types unduly we place an inferiority complex upon the lesser group. Mothers and fathers, and the students themselves, all wish to go beyond that curriculum for which native talent fits them. It requires an instructor of vision, personality and experience to deal successfully with aspects of human relations. Unless a teacher is so endowed his courses of instruction will be dead and unattractive. The instructor must refer to real cases drafted from his own experience and wide contacts with men. Text-book instruction will not suffice. There are plenty of text books, a new one every month from the press, but they require the breath of life from an instructor who understands the limitations of his pupil and who possesses a psychology of approach.

Again, the average student has no background in experience, no clear insight into the complex nature of technical problems and their relation to social, financial and political questions. If he lacks imagination, a text-book course by an inapt teacher becomes stale and unconvincing. Moreover, why attempt to teach leadership to men who at best can be only conscientious assistants? We may partly lift the young man into a new horizon, only to increase his disappointment through later lack in achievement.

I would applaud a whole-hearted, human-minded attitude in the teaching of all subjects in an engineering curriculum. Students should be impressed with the human values of their profession. We can create an attitude of mind for all students even though they do not become leaders. We cannot teach students formulas by which they may manage men or acquire the subtle qualities necessary to evaluate human actions.

The instructor who teaches surveying or electrical machinery or bridge-design, indeed any subject, has it within his power to digress from time to time to insert the human element into his discourse. I believe that with emphasis in this direction our engineering courses may become industrially minded and effective in their outlook toward business relations without depriving a four years' engineering sequence of the necessary fundamental subjects in technology and pure science. What I observe in some institutions is a tendency to teach men generalized courses for which they have not the talents to benefit and in place of training in fundamental technical elements.

I like to compare the personnel of a profession with the units

in an Army or a Navy. When we train men for military service we do not start out with the assumption that all are to be Generals or Admirals. There must be officers of lesser rank, while the great majority of the men must be privates or seamen. Similarly in an engineering school let us not forget that a great many of our young students are likely never to reach high positions. Most of them should be trained to be satisfied, contented and efficient surveyors, computers, inspectors, draftsmen, and construction assistants. These may seem like lowly terms, but great responsibility and broad technical knowledge is increasingly required in these services. For men so endowed I do not think advanced graduate courses are of value. Certainly it is a mistake that for them fundamental courses in engineering should be replaced by the theory of advertising, journalism, business management, or the psychology of human relations.

Of one hundred students who enter an average engineering freshman class, thirty-five after four years satisfy a B.S. degree at graduation. It is clear that these thirty-five already are highly selected from the great group of students who started in the primary and grammar schools. It is my impression that in after life these thirty-five men drift, partly through fate and opportunity and partly because of personality and fitness, into different departments of the professional army of life. Some get into engineering. Others desert or are transferred by accident or design into related fields of endeavor, very largely in salesmanship or business.

When we examine the army composed of groups of these thirty-fives, drawn from and combined with the graduates of many different schools and examine the achievements of this army, twenty-five or thirty years after graduation, I believe it can be shown that not more than twenty-five per cent of the number achieve considerable success either in engineering or in business or in other avocations into which they have drifted. The striking fact to me is, though it may seem disappointing and depressing, that not more than five per cent of this group, as a rule, acquire outstanding success or leadership.

Some will say that this minimum of leadership is the result of defective education, of the lack of English teaching, or foreign language, or psychology, or economics, or business law, etc. I claim it is the result of the native endowment of men.

Men in industry and business and teachers in colleges other than engineering seem readily to assume that our engineering schools are lacking in the wider outlook on life, in the ability for speech and presentation. I think this statement is unjust and not commensurate with the facts. Select any equal group of men and women in the varied professions and vocations of life and I believe you will find in comparing their achievement that they too have

twenty-five per cent of graduates of reasonable success and only five per cent with outstanding accomplishment, be they lawyers or doctors, ministers or politicians, business men or housewives.

My thesis then is that we make a mistake to require five and seven years of training after high school for all technical aspirants. Some should stop with high school, others at the close of a junior college of two years' sequence; still others will be satisfied by a technical institute, by correspondence courses and special short term schools or business colleges now so active in our larger metropolitan centers; schools with emphasis, on the one hand, on the manual arts and secretarial subjects; and, on the other, on courses in technical fundamentals, giving, as they claim, only the essentials and omitting the non-essentials of advanced theory, language, history and English, qualifying men promptly for the routine works of life. Such schools may train assistants well, and I have known men of leadership who have come out of such an environment.

Others of our students, more gifted, should be guided into a regulation four years engineering course with sufficient electives to allow some general training in language and industrial relations and, let us hope, by professors who have the capacity to insert into all subjects the human touch.

We should be on the alert to encourage those to still higher endeavor and broader training who have proved themselves mentally qualified and who show signs of the personality for management Such men may profit by graduate instruction, by combinations of engineering with courses in commerce and by post-graduate work in schools of business administration provided these schools have really something to offer and men on the faculty who have something to give.

Yet even here I challenge the assertion that all of our best students should be so trained and held in school so long. Engineering in my judgment has peculiarities which may offer to the ablest student a graduate opportunity in the actual field of business or professional accomplishment. To go straight from the engineering school at the end of a four years B.S. degree course to a great industry or to an enterprise like the Hudson River Bridge or the Panama Canal under the leadership of the strongest organizers and engineers, to join with other able men in a complex organization, is an opportunity not to be lightly swept aside for two more years of instruction in a graduate department of even the very best engineering school in the country.

I have known students of talkative temperaments with talents for easy and superficial acquisition who have been made still more talkative and less constructive in after life by too much weaning in graduate departments of our largest institutions where the student

may receive instruction in glittering generalities about human laws, human ways, human management and human problems in business or in profession.

Please do not accuse me of denying the worth of business colleges and offerings in the domain of industrial relations. I am attempting to phrase a word of caution lest we destroy our engineering schools by converting them into scholastic schools of argumentation and dialectics. Some men are born to speak well, others acquire expression, but few can have style in either writing or speech thrust upon them. The major problem of our teachers is to teach effectively rather than what to teach or how to gather information to be thrust into the skulls of students. It is training we want, mental discipline, the capacity to think and to express our thoughts. Educators of the business schools, if they are frank, must concede the difficulties to get mental discipline from some business subjects. A course in the psychology of salesmanship cannot take the place of precise analytical thinking or instruction in calculus and mechanics.

Some of our educators complain because young men leaving college lack the attributes of mind that are acquired only by the few as they draw nigh toward three score years. All the courses in all the colleges cannot take the place of experience in the counting house and in the market place. Men must learn from mistakes and failures; to relieve them of the temptation for mistake or the opportunity for failure is likely to make mollycoddles.

Recently in one of our western engineering schools commercial engineering was introduced as a four years option. The professor in charge wrote me that when this option in commercial engineering was established it at first had few students and most of these were originally students who had been registered for the normal engineering courses in civil, mechanical or electrical engineering, but who could not stand the hard work of these engineering programs. If industrial and commercial instruction is to have worth it must stand on a high plane and exact severe standards.

A college president at a Commencement address this June urged *simplicity* as a remedy for the ills which beset our American society. He mentioned business, government, recreation, education, religion among the civilized institutions suffering from too great complexity. At the University of California, Berkeley, our summer session is in progress. There they have fenced off one of the most beautiful sections of the campus at considerable expense to produce a children's play ground, so that expert teachers may teach teachers how to teach youngsters to play. I agree with this charge. Engineering students should have the fundamental bases of a technical profession. To dilute fundamental science and fundamental

engineering is to rob the student of essentials. He must acquire training in physics, mathematics, chemistry, mechanics, hydraulics, thermodynamics and strength of materials; even though in later life he may forget the drilling. The effect of the training remains in the mental processes and viewpoints of the eventual Engineer–Business Manager. To replace any of these fundamental courses by instruction in journalism, bookkeeping, statistical analysis and other general subjects of a business flavor is dangerous procedure. Oh, I wish we had time to discuss all aspects of this problem. A very notable and successful banker in San Francisco recently addressed our college of commerce. Politely, but frankly, he advised our professors to let the students graduate, then go to a bank to learn something about banking. The student and the professor alike may be deceived in evaluating such instruction when not based upon fundamental information and a reasonable amount of experience in the world of trade and construction.

I now turn to a summary of Pacific Coast offerings in social, business and industrial instruction, whereby our western engineering schools attempt to make young men socially minded upon the difficult problems which confront them at the threshold of a professional career.

UNIVERSITY OF CALIFORNIA

For B.S. students in civil, electrical and mechanical engineering, we assume that a considerable number, probably at least half, will enter the engineering profession through minor positions, at first more concerned with the business than with the technical side of engineering work. This has been increasingly the case in recent years, especially during the depression, with graduates in electrical and mechanical options.

We urge our students to acquaint themselves with the problems of industrial engineering, either by electives in the engineering departments or by selection of courses in the departments of economics, commerce, law, political science, etc. Bi-weekly conferences are held in our engineering departments for the benefit of senior students, where problems of adjustment to life after graduation are discussed by different members of the faculty or by invited guests.

Special Engineering Courses

Each engineering department offers at least one course of an industrial flavor. Thus in mechanical engineering students may elect a course in the theory of investment with application to engineering structures. This course is described below. It is our custom to post descriptions of this character for all generalized courses to attract students to elective subjects in any of our curricula. A paral-

lel course in the department of civil engineering is entitled engineering relations, contracts and economics. In mining are given courses in mine development and methods, economics of mining, mine cost accounting, mine valuation, cost accounting in petroleum production. Professors in irrigation engineering announce courses in irrigation institutions and economics.

Our senior students, candidates for the B.S. degree, must present a thesis for graduation. The student selects his subject, is required to take the initiative in its development. He is assigned a special adviser. Students with proper capacity are urged to use the thesis for studies in business, industrial management and economics. Our Engineering faculty assumes that industrial relations will be more prominently before us in the near future. The College of Engineering is considering a four years' curriculum with emphasis on industrial subjects in parallel to the present curricula in mining, civil, electrical and mechanical engineering. But in such a sequence the student must be competent to take the facts of pure science and the fundamentals of engineering and apply them for social purposes. No man is likely to achieve real eminence in the broader aspects of a social service based on Engineering unless he himself is a competent engineer.

To students who are fortunate enough to have the money, time and inclination and the mental and personal capacity for advanced training, the University of California offers a fifth and a sixth year, or even a seventh year, leading in the Graduate School to degrees in engineering, Master of Science and Doctor of Philosophy, according to the student's choice. Here the student may emphasize both technical subjects and industrial subjects. He may combine the opportunities of the engineering departments with the announcements in our College of Commerce—an entirely separate organization from our Colleges of Engineering. It is likely that the outcome of our present processes for dealing with individual students will result in a combined announced curriculum offered jointly by the Colleges of Engineering and Commerce wherein the student will receive training in engineering and in commerce subjects. Such a course by its nature must require more than four years' attendance and a degree higher than the Bachelor's degree.

In our College of Commerce there is a wealth of offerings in accounting, commercial law, corporation finance, statistics, auditing, cost accounting, income tax procedure, public utility organization, advertising, economics, applied psychology, management, insurance, principles of transportation; and many more, in fact too many, as can be gleaned from the Announcement of our College of Commerce. By this I mean no criticism of my colleagues in Commerce departments. We, too, in Engineering offer entirely too many courses.

The fault is not wholly ours. In a State University constant pressure is brought to bear by the public for specialized instruction. The taxpayer demands it. To some degree we must submit. In defense may I add that the great privately endowed institutions offer just as many courses of a like nature.

Our printed Announcements list courses and the arrangements of courses into curricula. Our advisory faculty system makes it possible for students with ability and intention to follow sequences not specially announced and which may be termed curricula in industrial relations or business administration with various avenues of emphasis.

I conclude with an example of an engineering course offered by the department of Mechanical Engineering.

MECHANICAL ENGINEERING 120

Mathematical Principles of Investment as Applied to Engineering Structures

TEXTS: (*a*) Putnam, T. M., "Mathematical Theory of Finance," 1925, Wiley;
(*b*) Eidmann, Frank L., "Economic Control of Engineering and Manufacturing," 1931, McGraw-Hill.

PREREQUISITES for course: Junior standing in the College of Engineering.

Description: This course is designed to provide the students with the tools for attacking the financial problems usually encountered in engineering practice, and to apprize him of these problems through the consideration of a number of typical ones selected from different fields. In consequence, the mathematical theory of finance will first be presented or rather, sketched. Illustrative examples will be solved by the class. Applications to engineering structures will follow. The course concludes with a consideration of the need for financial plans as well as design plans in engineering.

Outline of Course

I. *Introduction:*

The relation of the engineer to investment.
Effects of the introduction of mechanism or automatic machines.
First cost and ultimate cost.
Difficulties of defining cost; cost involves *time* and *depreciation;* money is affected by time.

II. *Mathematical Theory of Investment:*

Simple interest; compound interest; annuities;
Illustrative examples involving the use of tables.
Mortality tables and life insurance.

III. *Applications in Engineering Practice* selected from

1. Fixed costs and operating costs; balance in generating stations.
2. Load Division between Power Plants.

3. Load Factor and unit cost determination.
4. Economic Conductor Sections; Power Distribution Systems.
5. Comparison of production methods involving different unit costs and preparation costs.
6. Minimum cost point in manufactured lots.
7. Bonds and Sinking Funds for retiring them.
8. Depreciation and its effects: (*a*) Simple methods of appraisal. (*b*) Consideration as a problem in life expectancy.
9. Economic Maximum for Building Heights.

IV. *Statistical Method and the Laws of Chance:*

The probability curve.
Applications in study of depreciation.
Examples from (*a*) Cross Tie Replacements; (*b*) Telephone Cable Replacements; (*c*) Automobiles.

V. *The Need for Financial Plans in Engineering.*

References for Mechanical Engineering 120

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Fish, J. C. L. "Engineering Economics."
Goldman, C. B. "Financial Engineering."
Grant, Eugene L. "Principles of Engineering Economy."
Kimball, D. S. "Industrial Economics."
Kurtz, Edwin B. "Life Expectancy of Physical Property."
Lovell, A. H. "Generating Stations; Economic Elements of Elec. Design."
Nash, L. R. "Economics of Public Utilities."
Raymond, Fairfield E. "Quantity and Economy in Manufacture."
Tournier, E. J. "Materials Handling Equipment."
Underwood, G. "Estimating Construction Costs."

STANFORD UNIVERSITY

Stanford offers a two years' graduate curriculum in Administrative Engineering. Instruction in the business side of engineering began at Stanford in 1912 when the introductory part of the course, engineering theory of railway location, was separated from railway structures. The new course was entitled engineering economy, later changed to engineering economics. In 1919 the Department of Mining Engineering established for its graduate students three courses in valuation, organization and management. In 1925 there was set up a clearing house of engineering economics; also in that year the faculty of the School of Engineering voted to include engineering economics in the single undergraduate curriculum inaugurated at that time. Since 1930 each department of engineering has offered a two years' graduate curriculum in administrative engineering leading to the degree in Engineering.

The School of Engineering at Stanford now offers the following courses pertinent to administrative engineering: engineering economics, statistics, accounting, valuation, specifications and contracts, shop administration, mine valuation, mine organization, mine management.

The Graduate School of Business considers as essential to the two year graduate curriculum in administrative engineering: business economics, business organization, industrial management, personnel management, production management.

The courses in industrial management and production management are given by the Professor of Industrial Management in the Graduate School of Business. This officer is a mechanical engineer.

It will be noted that the offerings at Stanford are similar to the

opportunities at the University of California. Likewise at Stanford courses in the Departments of Economics and Political Science are available as electives in the Administrative Engineering curriculum. This curriculum requires a sufficient number of advanced courses in engineering to warrant the granting of the degree Engineer, in the respective groups, civil, mechanical and electrical engineering. The student is expected to plan a program of study in consultation with one or more of his professors, those most nearly interested. He then presents his program to the departmental faculty for approval.

At present the two years' graduate curriculum in administrative engineering is being pursued by seven of the eighty-eight graduate students in the Departments of the School of Engineering.

A course called "Personnel Management" is given in the Graduate School of business, open to graduate students in engineering. There is no formal course in the School of Engineering dealing *exclusively* with industrial relations in the sense that Professor Smith's course does at Yale. However, the course engineering economics required of all undergraduate engineering students, while laying primary emphasis on how to answer the question "will it pay?" in a variety of engineering situations also undertakes to stimulate the interest of the student in questions related to the administrative side of Engineering, and to the latter end offers the student an option of assigned reading on selected subjects. One of these subjects is "Industrial Relations and Personnel Problems." The reading covers all of Schell's "Technique of Executive Control" and some of the chapters in Lewisohn's "The New Leadership in Industry, Dennison's "Organization Engineering," and Tead & Metcalf's "Personnel Administration." This reading option is elected by about twenty per cent of the hundred and more students enrolled each year in the course "Engineering Economics."

California Institute of Technology

The Institute offers to engineering students the following courses in the Department of Economics: (1) General economics, governing production, distribution, consumption, with reference to important business and social problems of the day; (2) Selected economic problems in transportation, agriculture, labor legislation, socialism, labor policies; (3) Accounting, that is the interpretation of financial statements, a description of bookkeeping methods, emphasis being placed on actual business problems involving executive interpretation of accounting reports; (4) Business Law; (5) Social and economic organization; (6) Business economics. The

content of these courses is fully described in the Bulletin of the Institute. Some of these subjects are offered in a fifth year. Engineers may elect them in place of history, literature and philosophy. Out of a total of 53 units required in the fifth year nine units are devoted to these subjects, the remaining 44 being assigned to engineering, research seminars, and professional technical subjects.

In the undergraduate curriculum the idea is to give elementary economics, business law and accounting; no expansion is contemplated, as the prime objective is to equip students adequately in science or technology. If students take additional courses they do so as extra credit in mathematics, finance, statistics, financial organization, business administration and corporation finance.

Industrial accounting and industrial statistics is given in the second year, but only for extra credit. Eventually it is the plan of the faculty to transfer this subject to the Graduate Division.

In the fifth year and other graduate years advanced engineering students pursue courses in business economics, the work covering business organization, industrial promotion, industrial finance, industrial management, the marketing of industrial goods; an approach to the interpretation of financial statements, cost accounting, industrial statistics; four hours each week throughout the year. The class is divided into study groups for particular features of industry, usually aeronautics, communications or manufacturing.

Oregon State Agricultural College

The Oregon State Agricultural College at Corvallis conducts courses in agriculture, chemical engineering, commerce, engineering and mechanic arts, forestry, and mining. In the school of Commerce courses are offered in accounting and management, advertising and selling, agricultural economics, banking and finance, commercial education, economics and sociology, general business, government and business law, markets and marketing, real estate, secretarial training, with suggested combinations. In the School of Engineering, in addition to the usual curricula in civil, electrical and mechanical engineering, there are offered general engineering and a curriculum in industrial arts.

The Dean of the College of Engineering and Mechanic Arts described to me the future policy for instruction in Industrial subjects. Their work in industrial relations as embodied at present in engineering curricula may be regarded as in a transitory stage, divided into offerings by the School of Commerce and those in the School of Engineering. They prescribe a general course in the principles of economics and a course in accounting in all engineer-

ing curricula. These have been presented in the manner usual in Schools of Business Administration. In Engineering the faculty's policy is developing two differentiated plans, one related to industrial administration, the other supplementing the present engineering curricula in civil, electrical and mechanical engineering.

These two plans are in process of growth. A new curriculum in industrial arts has been outlined by the Engineering School with the title Industrial Shop Administration. This course is designed to train minor executives for shops and factories. The School of Vocational Education is coöperating. This course is described in the *Oregon State Technical Record* for May, 1928. The Professor of Industrial Arts explains that there is a need for men who are quite thoroughly conversant with mechanical processes and who have had some training in the management of men and machines and in the routing of materials necessary to the development of our modern industrial system. To meet this industrial need the Department of Industrial Arts of the Engineering School at Oregon State College has established the curriculum in industrial shop administration and is prepared to graduate those who complete the program with the degree of Bachelor of Science.

The Engineering faculty hopes eventually to develop this curriculum in industrial shop administration into a course in industrial administration but does not wish to dignify the course with the new title until the curriculum includes such subjects as production methods, economic and efficiency controls, and industrial administration. The faculty has a strong aversion toward calling any curriculum an engineering curriculum unless it embodies a training leading to some degree of mastery of the applied physical sciences. Engineering is characterized by the mastery of the general purpose tools of mechanics, thermodynamics, electricity, etc., together with an understanding of the technology of application. A curriculum which does not embody this technical training in the characteristic engineering way of thinking should not be called an Engineering curriculum even though it includes certain principles and practices of administration. For this reason at Oregon they propose to develop industrial shop administration into a curriculum of industrial administration rather than industrial engineering.

Because of the progressive trend of engineering graduates toward positions of managerial responsibility they likewise contemplate a stronger development of a collateral group of courses in the broad principles of economics, engineering economy, and administration. They have in mind at least three courses in the senior year treating these subjects; they are already partially outlined in the present civil engineering curriculum where in the senior year are offered courses in contracts and specifications, estimating and cost analysis,

and engineering administration; which latter might more properly be called economic organization and administration of construction. This third course is now taught by the Executive Secretary of the Portland Section of the Associated General Contractors. The faculty is looking forward to similar developments for economics of public utilities, rate making and utility controls, utility administration, industrial economics, cost controls, particularly for the curricula in electrical and mechanical engineering.

University of Oregon

At the University of Oregon among the professional schools are a School of Business Administration, a School of Journalism, a Bureau of Business Research and Public Service. In these departments students find training in finance, accounting, foreign trade, marketing, advertising, transportation, personnel management and production; courses in law may be taken in combination with courses in business administration. The Graduate Division offers advanced instruction in business administration. There is organized a Bureau of Business Research and a Municipal Reference Bureau.

University of Washington

The University organization includes a College of Business Administration covering fundamental scientific training in industry and commerce in a course of twelve quarters; a College of Engineering of six departments, aeronautics, chemistry, civil, commercial, electrical, and mechanical engineering with curricula of twelve quarters leading to degrees of B.S. There is a School of Journalism, a School of Law, and a College of Mines. A student therefore with the proper qualifications and interest, by a combination of offerings, may pursue training in Industrial Relations.

Engineering students who elect the option in commercial engineering receive instruction in industrial relations, business management and economics. The head of this department informs me that they insist upon making the commercial engineering curriculum of the same scholastic severity as the other engineering curricula in the school. He believes that the present industrial depression in immediate future will bring increasing demands from employers of engineering graduates for men who have a combination of training in technology and economics. He believes that the value of industrial training of proper standard will be more evident in the future than heretofore. He does not believe that students can be

taught to manage men but that they can develop certain attitudes of mind and secure a background, which will be useful to them in entering business or administrative aspects of engineering.

An examination of the catalogue of the College of Business Administration shows instruction in many subjects related to our topic, such as general economics, business law, practical business relations, accounting surveys, money and banking, industrial management, corporation finance, cost accounting.

State College of Washington

Instruction is given in Colleges of Agriculture, Mechanic Arts and Engineering, Mines and Geology. In the College of Mechanic Arts we find a curriculum in management engineering, commercial electrical engineering and commercial mechanical engineering. The College of Sciences and Arts operates a School of Business Administration. It gives courses in business administration, economics and secretarial science.

In the Engineering College each four year curriculum provides for instruction in industrial subjects. We find these listed in the sophomore, junior and senior years, such as economics, cost accounting, business law, money and banking, labor problems, and varied courses in business administration. These are found in largest percentage in the curriculum in management engineering but some of these subjects occur in all of the curricula, civil, electrical and mechanical.

University of Idaho

Amongst the divisions of the University concerned with our subject are the Colleges of Agriculture, Engineering, Mines, and the School of Business Administration.

May I interpolate the comment that all of the western institutions offer essentially similar opportunities in law, economics, business and engineering, so that a student may by combinations of courses in different schools or colleges adjust a commercial and industrial course of study over a period of four, five, or more years. Most of the schools publish such a suggested sequence or curriculum. In most of the Universities there are Departments, Colleges or Schools with such titles as Business Administration, Management Engineering, and the like.

Because of these similarities of organization, treatment and offerings, I do not attempt a complete record for any institution. It must be understood therefore that in my report I make ellipses and

omissions which the reader of this paper can supply by examining the Announcements, Annual Catalogues and Bulletins of the respective institutions.

The Dean of the College of Engineering at Idaho informs me that in civil engineering the students of the College are required to take prescribed courses in estimates and costs, engineering administration, and economics. In the other departments of the College of Engineering students have similar prescriptions, emphasizing quantity surveys, cost estimates, cost reports, economic comparisons of structures, organization, valuations, rate making.

University of Utah

Utah State Agricultural College

The Utah State Agricultural College maintains Agriculture, Forestry, Engineering and a School of Commerce. Amongst the prescribed courses in engineering we find: Office practice, general economics, business organization and accounts, irrigation institutions and management, engineering economics, contracts and specifications, highway administration. In the School of Commerce there are departments of Accounting, Business Administration, Merchandizing, Secretarial Work, each listing many courses. Also there are Departments of Economics, Political Science, Sociology.

The sister institution, the University of Utah, in its School of Mines and Engineering requires of all senior engineering students a course dealing with engineering economics, business law and industrial relations. Some of these topics are taught by Engineering teachers, others by instructors from the School of Law or the School of Business. In the sophomore year all engineering students are instructed in elementary economics taught by members of the Department of Economics. The Dean tells me that their future policy does not contemplate an increase in the amount of time devoted to these subjects. Nevertheless, a perusal of the catalogue will show that a student may remain longer in residence or attend in graduate status, and take additional subjects of a social nature.

University of Nevada

Amongst the Schools and Colleges of this University we find Engineering, Agriculture and affiliated organizations. The Professor of Civil Engineering informs me that he constantly advises engineering students to takes courses in economics, accounting, business administration and general psychology, some of which are

prescribed in the curriculum. In addition there are such courses as engineering economics offered by engineering professors. A perusal of the catalogue shows that in the freshman year all students receive an orientation course in general engineering.

In later years the curriculum lists elementary economics, economic geology, an introduction to economics and business, financial and business organization, technical reports, industrial organization, offered by departments other than engineering. In the senior year we find special treatments such as mineral industry economics, mine administration, given by the department of Mining; and by the professors of Civil Engineering such subjects as engineeering economics.

The Departments of Economics, Business and Sociology offer the usual list of opportunities such as principles of economics, public finance, money and banking and international trade, public utilities, transportation, insurance, statistical methods, labor problems and a group of courses appealing directly to business organization, such as administration of distribution, elementary and advanced accounting, administration of production and of finance, fundamental principles of law as applied practically to the professions, to business and citizenship, advanced business law, cost accounting, income tax accounting. There is a group of subjects under the heading sociology—principles of sociology, social problems, social institutions.

University of Arizona

The Dean of the College of Mines and Engineering tells me that all engineering students are required to take six units of economics. Many of his students can and often do take additional electives in the Economics Department. Many members of the faculty at Arizona have had successful industrial experience so that industrial relations and business management are included in many of the technical engineering courses. The School in normal years arranges for visits to the campus by successful executives who address the engineering students. Sometimes these visitors deliver courses of two, three or more lectures. In the College of Letters, Arts and Sciences there is a major requirement in business administration including accounting, agricultural marketing, finance, general business, merchandizing, public control, insurance. These courses may be taken by engineers. The tabulated curricula in engineering include prescriptions in English, economics, business law for engineers. There is a group of departments headed, Economics, Sociology, Business Administration.

The catalogue lists some unique offerings. The Dean at Arizona

called my attention specially to a course in engineering economics offered in the department of electrical engineering which is elected largely by senior and graduate students in civil, electrical and mechanical engineering. This course deals with business problems requiring a knowledge of engineering for their solution. Problems in investments are analyzed. Factors involved in the success of this analysis are studied, such as first cost, operation costs, public and private corporations, business statistics, forecasts, valuation, estimating.

In the department of Mining and Metallurgy is offered a course entitled, Seminar in the Administration of Mineral Industries, for graduate students and seniors. The subject matter includes mine, mill and smelter operation and management. This is followed by a seminar with field work in the administration of mineral industries, a course open only to candidates for the degrees, Administrative Engineer of Mines or Administrative Metallurgical Engineer. Admission is allowed only to those who have demonstrated qualities of executive ability. It is claimed that no other college in the country offers a similar course. Such a course may be offered whenever an instructor with the proper practical background and personality appears and especially where the institution lies in the locality of the industry discussed.

These courses in the administration of mineral industries, in a first semester, include business finance, business organization, administration and management, public speaking, business law, and administration seminars with field work. Electives are offered in sociology, a seminar in business administration and statistical methods in business. The second semester consists of laboratory work. The student goes to various mining camps in the State where opportunities are given him to study details of operation in mines and smelters. He studies plans of organization, accounting systems, methods of handling supplies, bonus systems, social and economic conditions, attitude of employees, welfare work. The number admitted to the course is tentatively set at twelve men. The best qualified men are selected if the number applying exceeds twelve. The cost of the course is considerable. The student must be earnest to elect it. In the elaborate announcement for this course at least sixteen coöperating companies are listed who have agreed to permit students to study their operations and where officials of the companies in mines and smelters give the student as much aid as they are able to render.

I have mentioned this subject in some detail since in other localities and institutions peculiarly located and qualified, courses of a similar nature might be developed to train students in the arts of industry and industrial relations. There is opportunity in these

directions for limited numbers of students in selected departments, where the leader is a professor willing to sacrifice himself; an instructor who has the personality to interest neighboring industries to serve and coöperate.

University of Colorado

At Colorado we find five Engineering curricula, Civil, Electrical, Mechanical, Chemical and Architectural; and a School of Business Administration. The College of Engineering is in close touch with the School of Business Administration. A considerable number of students elect work in related subjects from both groups. The engineering curricula are being re-arranged with the attempt to produce more free electives so that courses in Business Administration may be selected by those engineering students interested in the business side of engineering and industry. The Dean stated that he does not believe it possible for an engineering student who pursues a thorough and serious four years' course in engineering to devote any large percentage of his time to the study of business details. He believes that all engineering students should secure some of the fundamentals of business and at least enough insight into past and present business conditions and human relations to enable the young man to appreciate what those who are not engaged in engineering may be doing and thus to give to the student of engineering some understanding of the economic structure upon which engineering projects must be founded.

In the tables of courses listing the requirements for the degrees of B.S. in Engineering we find engineering economics, highway administration, engineering administration; engineering contracts, estimates and costs, organization and management, works management, industrial safety engineering.

University of Wyoming

Among the Colleges and Divisions of the University we find a College of Engineering and a College of Agriculture. In the College of Liberal Arts there is a division of Commerce. The engineering departments offer courses in industrial engineering treating of various phases of management. In addition to the usual text book assignments on principles of industrial management and kindred subjects, the classroom lectures and problems supplement the principles studied with practical examples. In a second year a course in industrial management continues with problems of organization for corporations; it deals with designing a project, tooling a product

and designing a factory to care for the machinery for the project chosen.

The faculty encourages engineering students to take subjects in economics and political economy. Their undergraduates are required to have at least three hours' credit in political economy and three units' credit in political science. They allow the students to elect other subjects, particularly in Economics, with credit toward graduation. Many of the engineering students devote considerable time in the Department of Commerce in preparation for work in the field of industrial management.

I am informed that the faculty attempts to encourage students to elect general subjects, economics and business management, in keeping with the general trend of engineering education.

Conclusion

I am aware that I have omitted reference to many other western institutions, such as the School of Mines at Golden, Colorado, or the Agricultural School of that State. I have made no references to the University of Montana, or Schools in New Mexico. These have not been omitted by design. A perusal of their catalogues will show that they are cognizant of the engineering demands for instruction in industrial relations. I think I have presented enough evidence to show that institutions west of the Rocky Mountains are doing whatever is possible to offer engineering students instruction in social, economic and industrial subjects. The limit is solely the time available and the need for fundamentals in pure science and its applications.

JUNIOR COLLEGE MOVEMENT ON THE WEST COAST *

By BALDWIN M. WOODS

Professor of Mechanical Engineering, University of California

When a man moved into a town in 1905, constructed a house better than the average, purchased an automobile, and proposed the organization of a country club, he was described by his neighbors in two ways. To some, he was an officious newcomer, upsetting the traditions of the community, an advocate of extravagant living, and a supporter of radical ideas. His influence was expected to result in high taxes or at least in greater individual expenditures, to be a bad example to youth, and to exhibit a disrespect for the established order. On the other hand, some of his associates believed that he symbolized the beginning of a new era; to them he represented the automobile movement. They, too, aspired to automobiles, to mechanized homes, and to country club pleasures. They admired his courage and were prompt in acclaiming him the prophet of a new day.

The foregoing example of what many of us saw and heard twenty-five years ago illustrates the reaction of human nature to new things. When a community learns nowadays that a neighboring town has extended its local educational system to include the thirteenth and fourteenth years and that it calls the new unit a junior college, the comments range all the way from severe condemnation to high praise. Those who condemn will find justification for criticism in the increased difficulties of articulating the new school with higher institutions of learning, in the effect on standards of teaching—which is temporarily and sometimes permanently adverse—and in the chamber of commerce methods used to promote the expansion. They will be wearied by many claims of superiority of the new plan, only some of which can be substantiated.

Perhaps chamber of commerce methods of educational development are well known to you. There is a case on record where the president of a large university received a committee from the chamber of commerce of a small city. The chairman of the committee explained that the group had come to inaugurate a campaign for the establishment of a branch of the university in the small city where they resided. They explained in detail the financial

* Presented at the 40th annual meeting, S. P. E. E., Corvallis, Ore., June 29–July 1, 1932.

benefits which would accrue to the city in question by such action. The president of the university asked what educational needs existed and what kind of branch they wanted. Their reply was to the effect that it did not make any difference, just so they had a branch. Modern advertising methods make such procedure common.

In the same city with the critics, others will be found who will regard the new institution as one affording needed opportunities for boys and girls unable for various reasons to attend institutions distant from the community, even with the present ease of transportation. They will find numerous other reasons entirely convincing to them for providing the new step.

After what has been said, one can surmise that the speaker is more interested in the analysis of the junior college movement and in its reasonable appraisal than in its promotion. In fact, it is likely that, as far as the state of California is concerned, the promotion of junior colleges has been achieved. There remain a few gaps, but it is significant that exclusive of the freshman and sophomore years' instruction, located in the standard four-year colleges and universities, there are now in California thirty-six or more public junior colleges, distributed widely over the state. So far as I know, only the communities with very small population, scattered sparsely over a wide area, are not served by these institutions. Some statistics concerning growth, development, and financial support will be given later. At this point it is desired to emphasize two general trends of national thinking and achievement which have influenced the establishment and growth of the junior college.

For several decades it has been characteristic of American communities to be liberal toward education. Every one of us has heard parents discuss their own lack of educational opportunities in youth and their resolution to have their children profit by better training. This conviction has amounted to a religious fervor and has so dominated communities of the country that general education provided for the children of all citizens, regardless of wealth, position, race, or even of native ability, has been carried to a point not yet attained in any other large nation. We are all familiar with this feeling and its effects. The step in the development with which we are best acquainted is the extension of high school facilities. For example, in 1891, it is reported that there were only six high schools accredited to the University of California. At the present time the number is well in excess of 400. I believe that there is no high school of any size or importance which is not so accredited. In 1891, approximately 4 per cent of the children from age 14 to 17, inclusive, that is to say, of the traditional high school years, were in school. This amounted to 1 in 25. In California at the present time approximately 76 per cent of the children in this age group are in school.

Thus the high school has increased many times faster than the population. Brief reflection will indicate that its future possibility of increase will not greatly exceed that of the population.

The great result of the increase in general education, in the minds of most people, was the extension of the training of the average child both in variety of material and in number of years. The high school became the peoples' school. All children were accepted and intended to be graduated—not just a selected few. The process is not yet arrested. The question now under discussion is "Will the junior college follow the same course?" There are many who believe that it will. In support of their views they cite the following: (1) The growth of the public junior college in California, especially, since 1921 (for details, see Appendix A); (2) the established willingness of communities to pay large sums for the support of these institutions; (3) the increased average age for employment, which is closing doors of employment to many high school graduates, and (4) the demands upon youth of a civilization of steadily increasing complexity.

For these reasons it is stated that we must expect the further extension of general education, going two years beyond the high school. In fact, as soon as the junior college has become an established institution in some communities, there has been a demand for the so-called complete or four-year college. Up to the present time, however, no such institution has been authorized in California. It is the general opinion of experienced educational investigators that the first two years of the old-fashioned college may be attached to the high school as an upward extension, but that it will prove equally logical and important to retain the upper years of the college exclusively in the universities. In other words, the junior college comprises the terminal years of secondary education. The junior and senior years of college are considered the beginning years of professional training and specialization. In the manner outlined, because of the general belief on the part of parents and taxpayers that education beyond the high school is justifiable in the community as a part of the general school system, the junior college has achieved its present rank. A few statistical items will serve to indicate that the movement is beyond the initial stages and that the junior college is an institution with which all established universities and colleges must now reckon. In the judgment of the speaker, the present rate of increase in enrollments indicates that by no means has full size been reached and that the next few years will continue to call for readjustments within our entire higher educational system to care for articulation with this new institution. Colleges of engineering which have long emphasized the unity of their four-year programs are already affected; they are likely to

be much more affected in the not distant future. For one thing, they may expect a much higher percentage of intrants with advanced standing.

Thus, the junior college may be regarded as an outgrowth of a religious faith, one may call it, in education for the masses. It amounts to an upward extension of the public school system, at least in prospect. The existence in the city of Los Angeles of a junior college which in a life of only three or four years has attained an enrollment of over 3,400, and that in spite of the presence in the same city of two large universities and several colleges of fair size, would indicate that progress toward that end is already rapid.

The American people do not like to consider themselves communistic or socialistic; nevertheless, the support of public education is a support of this kind. All who have are taxed for the benefit of the children of the community. There is no relationship between one's having children and one's being taxed for schools. Of course, the same may be said of public health service. The clinic is operated not on the basis of the taxes one pays but on his need for medical service. Public health measures of prevention also are not made to care simply for those who have means, more frequently they are for those who have not. In so far as the junior college is provided at public expense, it is another expression of this political philosophy.

Up to this point the junior college has been considered as the actual result of parental desire for opportunities to children, and of local pride and ambition. Slight reference has been made to the fact that specialization or the beginning of professional study follows general education and that in some cases, notably in Germany, general education has been the function of the secondary schools, and professional education the duty of the universities and of a few special schools.

The second governing force in junior college development is the compulsion of getting a job. There has been so much emphasis in recent years on the Russian experiment, in which all the citizens are supposed to be workers, that one is inclined to overlook the fact that there is no leisure class in America. One or two generations ago there were men of leisure. There were men in every community who retired from business and professional life long before the age which we now consider appropriate for retiring, and who then devoted themselves to such pursuits as pleased them. Frequently they had good libraries and they read extensively. They were sometimes in demand as speakers. They were active in the benevolences of the community. They occasionally took part in politics, usually in an amateurish way. So far as can be learned,

this class has now disappeared from the country. One would suppose from the behavior of Americans that feverish activity in a profession or job is the most important compulsion one feels. On every hand one encounters the belief that every man should be fitted for a job, and every woman as well. We are acquainted with the growth of vocational education in high schools. We are aware of the change in high school requirements for graduation so that, not merely those students who are to go on to college and there secure professional training may graduate, but also those who have pursued vocational courses, fitting themselves for jobs, may receive diplomas. We are all aware of the difficulties that follow when a student with such training, from which subjects basic to the study of engineering have been omitted, decides at a later date to pursue engineering. To many it has seemed that the junior college is an ideal institution for providing two years of professional training at an intermediate level for boys and girls who will not normally undertake the professional courses of universities. It is probably safe to say that more than ninety per cent of all students in high school, junior college and university have vocational objectives. It is sometimes thought that the students in colleges of liberal arts are studying the subjects in which they "major" exclusively for the sake of culture. That they receive cultural benefits goes without saying, but it is significant that the fields of English, history and the languages, which are so prominent in the liberal arts colleges, are the very fields in which the largest surplus of unemployed teachers may now be found. A report from the State Department of Education of California, which has recently reached my desk, indicates that on November first last, the number of unplaced candidates, according to the placement agencies of California teacher training institutions, was 2,514. The largest numbers of such teachers were as follows: English, 246; History, 215; Foreign Language, 238. Science, which includes agriculture and fourteen other subjects, numbers only 157. Social sciences as a group include 365. It is apparent to those who question students and who observe activities of graduates that all institutions of learning and all colleges in them are to some extent professional colleges.

It is evident that the educational system of America as it is now developing will provide vocational or professional training for students at all levels. Students who complete their training in the high school may there receive the special instruction which will permit them to take jobs upon graduation. The same is, or will be, true of the junior college student and of the college student. In the past we have thought of the term "profession" somewhat narrowly so that to the average discussor it has meant a calling re-

quiring a number of years of university training. For the purposes of this discussion the term used should perhaps be "vocation" so as to include types of jobs which may be entered at any level. It seems likely that colleges of liberal arts will recognize in increasing degree their obligations for professional training and will therefore come to resemble professional colleges and schools like those of law, medicine, agriculture and engineering.

One point is especially significant with reference to the junior college; if the American people experience prosperity, then parents can afford to send their children to school longer than they otherwise could. It is the opinion of a recent State Superintendent of Public Instruction of California that a large percentage of students attending junior colleges during recent years have been sent by their parents because it seemed wise to defer the time at which they should go to work. Doubtless, it was also desired to have them equipped more adequately for the complexities of modern life. In time of depression, unemployment makes it difficult to obtain positions for boys and girls of eighteen and nineteen. It is then profitable for them to continue in school in order to spend their time to advantage and also to become better equipped to secure employment in competition with others. It therefore seems likely that whether times are good or bad, vocational training in high schools is likely to be less significant in the future than vocational training in junior colleges. Experience of older civilizations supports this point. The apprentice period in European countries sometimes carries one up to age thirty before permanent employment is found. Of course this is more characteristic of the professions than of the vocations. There are, however, many people who point to the rising minimum age of employment and believe that specific vocational training in the high schools is likely to become in large measure a thing of the past. Professor Davis will speak presently in greater detail concerning the manner of developing useful vocational or semi-professional training in the junior college.

To review briefly, there are two influences of major importance encouraging the development of the junior college. The first is the belief of the people that general education is a good thing, especially for their own children, and that an upward extension of general education to include the junior college is justifiable. The resulting development has made greater progress in some parts of the country than in others. It is too early to appraise the effect of the world-wide depression on this belief, but it is probable that the faith of the people in education will continue. The second influence, that is to say, the necessity of preparing for a job, taken in conjunction with the rising age of initial employment, is forcing general vocational or semi-professional education above the high school

level. This is resulting in the belief that vocational education should be based upon broader general training than in the past. In consequence, there is a disposition to postpone specialized vocational training to the junior college period. One of the chief reasons for this belief lies in the fact that many jobs are less stable than they used to be. About three years ago the General Electric Company closed its foundries at Erie in which there had been employed at one time seven thousand men. The close was not due to the depression but to the fact that modern methods of assembling machines made the foundry largely obsolete. Doutless many of the workers employed were skilled men at their jobs. Since the closing of the foundry was not an isolated instance but was typical, the men concerned were in most cases obliged to seek a different type of job. Ability to make such changes calls for a broader basic training than is necessary if one may continue the same job throughout life. This has seemed so clear to the head of the largest junior college in California (an institution in which semi-professional training is the major purpose), that he expresses it in this form: "The student should be trained so that his general background is sufficient to permit him to readjust himself in industry. The training should be sufficiently specific to provide what may be called a 'snapper' with which he may take hold of the first job." Thus the two important influences are in large measure working toward the same end.

Another division of education closely associated with the junior college and to which brief reference should be made is adult education. Charles Allen Prosser of the Dunwoody Institute says: "Roughly about seven million American citizens are seeking during the current year to improve themselves through some form of education, of training. That, in itself, is a staggering fact to those who have never thought about the great numbers of mature people who are in one way or another taking organized instruction—a great part of which is vocational in its purpose." We have grown accustomed to the evening high school and its service to adults. It is surprising to learn now that one junior college in California, during the year 1930–31, had over four thousand adults enrolled in short courses. This institution, moreover, was located in a relatively small city, one of not more than forty thousand inhabitants. With the increasing age level of employment and with the increasing demands for flexibility and adjustibility, it is likely that the demand for adult education will grow rapidly. Moreover, one of the most serious problems encountered throughout public education—that of financial support—can probably be more easily met in adult education than elsewhere. Examination of courses given under a number of agencies indicates that the cost is not beyond a reasonable tuition fee. Since adults have already reached the earning period, and

since those who take the work are the ones who profit by it, it would seem entirely reasonable to charge tuition fees for adult education sufficient to cover the cost. This practice is already in effect in certain localities in California. In a large university with which I am acquainted, the extension division deals with many thousands of adults, charging a fee of from forty to fifty cents per hour for instruction. This division receives support at the rate of $80,000 per year on which it conducts a business of approximately a half million dollars per year. Thus an increase in the fees of only twenty-five per cent would make the work self-supporting. This is an important factor in view of economic demands for other levels of education—demands which promise not to diminish with time. The question of adult education is mentioned at this point because it has a natural place in the junior college. It usually results in more efficient use of the plant. In addition, the presence of the junior college furnishes an educational administration for such work in a community. As is often the case, those who are in need of such instruction also need leadership and organization in order to secure it.

For the benefit of those who desire to know some of the more interesting facts concerning the development of junior colleges in California, the numbers enrolled in these institutions, the means of support and the costs of operation, a table has been prepared which is attached as Appendix A. It may be explained briefly that the organization of the institution depends upon local initiative and requires an election within the district affected. The control is then vested in the "junior college board," which may also be a high school board. The support comes from state funds and local taxation. This is the same system that is used in California for the support of high schools and elementary schools. The percentage of state support increases with the grade of the school. Elementary schools have a small percentage of the cost supplied from state funds; high schools a larger percentage; junior colleges, still larger.

To most of you the preceding discussion will seem either to present a remote contingency or a vexatious problem. But colleges of engineering in the vicinity of junior colleges are obliged at the present time to take account of training in those institutions. If, for example, the College of Engineering of the University of California inserts a new laboratory course into the first or second year of the engineering curriculum, it is almost certain that within three years every junior college in the state will insert the same course and will attempt to provide the necessary laboratory equipment. On this account the freedom of action of the higher institution in dealing with the first two years of work is affected. Very interesting results often follow logical changes. One may find one of his

recent engineering graduates attempting to give instruction in a junior college simultaneously in plane surveying, engineering mechanics, machine design, aeronautics, etc.

The junior college will desire to keep boys as well as girls in attendance. It is necessary to have football and other athletic teams. Therefore, students who might otherwise come to the university as freshmen or sophomores, come as juniors. In the fall of 1931, new engineering intrants at the University of California (Berkeley departments) numbered 271; the number of new students entering with junior standing was 85, of whom 64 came from junior colleges. The problems of adjustment of these students can readily be surmised. In the University of California as a whole, for the year 1931–32, there were approximately 1,000 students entering with advanced standing from junior colleges. At present, the numbers for each year show a material increase over the preceding year. Problems of readjustment are certainly before us in California and they are probably imminent in many other parts of the country.

A sage of other days remarked that nothing is permanent but change. It is apparent that in this field as in many others we shall gain stability for the future only as Professor Kilpatrick of Columbia University suggests. He believes that we must seek dynamic, and not static equilibrium; the equilibrium of the bicycle, which is lost if progress ceases, rather than the equilibrium of the arm chair.

APPENDIX A

Statistical Addenda

District Junior Colleges

Note: By *district junior college* is meant a junior college organized and controlled by a political subdivision of the State, called a junior college district, which has been set up for that special purpose.

District Junior College	Average Daily Attendance	State Enrollment			Expenditures per Pupil in Average Daily Attendance	
		Male	Female	Total	1929–30	1930–31
Chaffey	520	1,340	1,538	2,878	485.00	488.20
Compton	528	418	197	615	194.00	254.09
Fullerton	408	266	254	520	354.43	402.30
Glendale	583	414	350	764	374.10	297.40
Long Beach	1,010	854	634	1,488	242.75	255.97
Marin	367	349	304	653	473.50	395.11
Modesto	657	782	646	1,428	276.54	222.10
Pasadena	1,547	883	888	1,771	248.38	210.24
Riverside	381	479	260	739	388.39	392.14
Sacramento	1,415	1,062	1,302	2,364	228.46	199.49
San Bernardino	497	2,095	2,656	4,751	400.65	316.37
San Jose	626	515	287	802	184.33	184.60
San Mateo	698	561	647	1,208	247.34	271.64
Santa Ana	537	371	413	784	352.98	292.93
Santa Rosa	266	179	119	298	222.40	403.19
Yuba County	152	110	87	197	419.02	400.40

(Above statistics excerpted from State of California Department of Education Bulletin, No. 1, January 1, 1932.)

Departmental Junior Colleges

Note: By *departmental junior college* is meant the thirteenth and fourteenth years of secondary school work as offered by a department included in a public four-year high school.

High School District and Junior College	Average Daily Attendance	State Enrollment		
		Male	Female	Total
Antelope Valley Joint Union	22	10	20	30
Brawley Union	33			
Central Union:				
Central Union	108	81	42	123
Eastside	7	2	6	8
Citrus Union	105	71	56	127
Fresno:				
Fresno	269	252	105	357
Fresno Technical	48	23	126	149
Kern County Union	276	190	166	356
Lassen Union	30	10	31	41
Los Angeles	2,699	1,484	1,201	2,685
Pomona	123	93	73	166
Porterville Union	100	71	49	120
Reedley Joint Union	62	34	37	71
Salinas Union	64	50	61	111
San Benito County	116	113	94	207
Santa Maria Union	100	58	79	137
Santa Monica	350	228	150	378
Taft Union	153	114	113	227
Ventura Union	141	93	113	206
Visalia Union	117	66	95	161

(Above statistics excerpted from State of California Department of Education Bulletin, No. 1, January 1, 1932.)

Standards Required and State Support Provided

"The first junior college law in California was passed in 1907. This law permitted a high school to offer postgraduate courses. It set up no standards. Ten years later this law was repealed; and another law was passed which required the district to have a minimum assessed valuation of $3,000,000 before it might offer such courses. The law of 1921 raised this minimum to $10,000,000. It also required a high school A. D. A. of four hundred in the proposed district, as well as the approval of the State Department of Education, and of a district election. In 1929 these standards were raised again, and the proposed district was required to have an assessed valuation of $25,000,000, and a high school A. D. A. of one thousand.

"The junior college fund, established in 1921 from revenue received from the Federal government, has proved insufficient to provide the apportionments stipulated by the 1921 law. The junior colleges of the State now face a shortage of about $400,000 in their 1932–33 State apportionments.

"In view of all these facts, the legislature of 1931 repealed much previous junior college legislation. The present law sets up only one standard, but states that the State Board of Education shall draw up a list of requirements for the establishment of junior colleges. The State Superintendent of Public Instruction shall then conduct or have conducted a survey of the proposed district, and shall recommend action to the State Board of Education on the basis of this survey. After receiving approval from the State Board, the district may then conduct the required election."

(Quoted from Joyal: "Junior Colleges in California," *Univ. Calif. Publ. Educ.*, Vol. 6, pp. vii + 359–453.)

Note: In addition to state support, the district may levy a district tax not in excess of twenty cents on each one hundred dollars of the estimated true wealth of the taxable property of the district. The taxes so levied vary.

Minimum Standards Recommended for a District Junior College

"The basic minimum standards for the establishment and maintenance of a district junior college are:

A. An area with a maximum radius from the proposed junior college of twenty miles.

B. A minimum high school A. D. A., within the proposed district, of 1250.

C. A minimum of 200 junior college A. D. A. is necessary to provide enough students to furnish registrants for the absolute minimum number of courses offered as a curriculum in a California junior college. No institution, however, can be expected to confine its offering to such a small number of courses. If the offering of the small-

est district junior college in California be used as a criteria there should be enrolled a minimum of at least 333 students.

D. A minimum of eight full-time teachers, exclusive of administrative or supervisory officers.

E. A minimum offering of 120 periods of work per week, in no less than 20 courses per semester.

F. Sufficient assessed wealth in the district to raise $15,900 per year for current expenditures, within legal tax limits.

"In conclusion, it may be stated that assessed valuation and tax rates are not to be considered as the final determinants for establishing a junior college district. Educational factors are quite as important, if not more so. Local patrons of a junior college may decide that a junior college should be maintained irrespective of what it will cost, but as indicated in this study, unless student groups of certain sizes are provided, it is doubtful whether the desirable educational objectives can be achieved in the several courses. In the light of this fact, a potential minimum number of students should be available within each new junior college district established in California."

(Quoted from Joyal: "Junior Colleges in California," *Univ. Calif. Publ. Educ.*, Vol. 6, No. 6, pp. vii + 359–453.)

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(*Note:* For a complete bibliography on the Junior College, see W. C. Eells, "Bibliography on Junior Colleges" (Washington, D. C., 1930), U. S. office of Education Bulletin (1930). 2: iii–ix; 1–167.)

FUNCTION OF THE JUNIOR COLLEGE IN ENGINEERING EDUCATION *

By RAYMOND E. DAVIS

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The opportunities for occupation in the fields of engineering may be divided into two general classes: first, those which are strictly professional in character, and second, those which are more or less closely related to the professional but are on a level intermediate between the professions and the trades.

In the first class are the opportunities in what may be regarded as the higher rounds of the engineering ladder. Those who are employed in these occupations are spoken of as professional engineers.

In the second class come not only the occupations in what may be spoken of as the lower rounds of the engineering ladder but more particularly those occupations, so frequent in industry, where there is necessity of a general knowledge of the practise of engineering coupled with an intimate knowledge of particular industrial processes. Those who are employed in these occupations are the draftsmen, technical assistants, inspectors, foremen, superintendents and plant managers.

To serve the educational needs of those who are fitting themselves for professions in the first class, there are the traditional professional engineering colleges in which training normally leads to the bachelor's degree in four years. We are all familiar with this type of institution, with its more or less closely defined curricula in civil, electrical, mechanical and mining engineering, where particular stress during the first two years is laid upon a thorough grounding in mathematics and natural science and where during the last two years, based upon this groundwork, there is developed the professional foundation.

To provide training for those who will enter occupations in what may be called the semi-professional fields or those intermediate between the trades and the professions, there are the schools of the technical-institute type, most of which are essentially private in character, with curricula designed to give the student a relatively meager knowledge of mathematics and natural science but designed

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to provide in a relatively short period, training of intensely practical nature so that at the expiration of the training period the man without further experience may take a definite place in industry.

In considering candidates for admission to schools of the technical institute type, generally speaking, comparatively little attention is given to the quality of the student's preceding educational record so that normally any person who is a high-school graduate may enroll, and often entrance with less than high school graduation is permissible. The curricula vary greatly between institutions, depending upon the industrial needs which the institution is designed to meet. The period of training is comparatively short, generally not more than two years in length, and usually no degree of any sort is awarded at the time of graduation.

During the past few years, there has sprung into existence the Junior College as an institution on the post-secondary level, offering education for a two-year period beyond the high school. As a private institution, the Junior College has been almost entirely concerned in preparing students for the last two years of standard four-year colleges and universities. In other words, the courses which they offer are almost entirely of the academic or pre-professional type.

In our western states, particularly in the state of California, there has been developed the two-year public Junior College as an institution with two principal functions. The first of these functions (the preparatory) is to provide education such as is offered by our four-year liberal arts colleges during the first two years. The second (the terminal) is to train young men and women to become economically independent, through fitting them for places in the industrial world. In California alone there are some thirty junior colleges of this type, in which the total enrollment during the academic year just brought to a close was more than 20,000.

I should like to speak of the efforts that are being made by some of our Junior Colleges of the West to fulfill these functions in the field of engineering education, but I should first like to bring to your attention the need in our public school system for more complete engineering educational facilities in the semi-professional fields.

The recent investigation carried out under the auspices of the Society if nothing else, has served to emphasize the grave deficiencies in American education by calling attention to the opportunities which exist in the various branches of industry for those who are technically trained, and at the same time has shown how few in number are the public institutions which offer adequate training on a semi-professional level in the engineering and technical fields.

From my own experience, coming into contact with a consider-

able number of industries, I have long felt it as a serious indictment of our system of American education that so little attention should be given to this type of training. Except in the field of agriculture, which is served to some extent by two-year schools, taking the country as a whole, adequate semi-professional training, particularly in the engineering field, is provided almost entirely either by schools conducted by the industries themselves or by technical institutes run for private gain. There are, of course, a few notable exceptions to this statement, with which exceptions we are all familiar.

In other words, our system of public education has given all attention to the extremes; on the one hand are the vocational schools providing for the trades, on the other hand are the universities and other degree-granting institutions, offering only the extended curricula in the professional fields. If those who guide the destinies of education in this country are to do their part, this deficiency must be remedied, and in no field is there greater need for comprehensive development in this direction than in the field of engineering education. The country as a whole must no longer be indifferent to the advantages which would accrue through a system of public education which would provide adequate engineering and technical training for that large number going out into industry, for this has come to be an industrial nation and upon adequate training in these fields, perhaps more than upon anything else, the future material prosperity of this nation depends.

It is a tribute to the early advocates of the Junior College in the state of California that they very clearly had in mind a type of training designed to meet the needs of that great mass of young men and women of the middle group between the trades and the professions, preparing them to take their places in the industrial and social scheme and fitting them to achieve economic independence. At the same time, the preparatory function of the Junior College was not overlooked.

Speaking as one who has observed with interest the development of the Junior College in the State of California over a considerable period of time, especially as this development has been related to engineering education, it is my conclusion that the outstanding achievement has been in the semi-professional field and that the Junior College may perform a great service to engineering education by providing adequate training facilities on this level.

So far as the four-year curriculum in engineering is concerned, it is believed that in general the student, if he is qualified for admission at the time of high school graduation, should spend the entire period in the engineering college from which he expects to receive a degree. From studies of a considerable number of cases

of those who have transferred from Junior Colleges to engineering colleges after one or more years spent in the former institutions, it appears that the sooner the engineering student becomes enrolled in the engineering college of his choice, the better. This is also the sentiment as expressed by the testimony of the great majority of the student transfers themselves.

There are several reasons why the fully qualified engineering student normally should not attempt to pursue the engineering curriculum of the first two years in a Junior College. The courses offered in many of the Junior Colleges, especially the smaller ones, are taught by instructors with little or none of the background of engineering experience. The students do not have the opportunity to come in contact with more advanced students and with engineers engaged in professional practice. They do not have the opportunity of visiting engineering laboratories. There is nothing about the smaller Junior College of engineering flavor. The student acquires no professional consciousness. Often the student is ill advised, and frequently the offerings of the Junior College are inadequate. The result of this is that when, after spending say two years in a Junior College, the student enters the third year of an engineering college, the readjustments are so numerous that in a large number of cases a fifth year is consumed in his engineering training before he is able to graduate.

In striking contrast are the efforts being made by a considerable number of Junior Colleges, particularly the larger ones, to provide training in the semi-professional fields related to engineering. At the present time, in California not less than ten are offering curricula of this type. I should like to speak in particular of Los Angeles Junior College, an institution only three years old, in which the total enrollment for the academic year just brought to a close was 3,400. Of this number probably 80 per cent at the time of high school graduation were ineligible for admission to the University of California, and it is fair to assume that approximately this number are of the type to benefit most by training on the semi-professional rather than upon the professional level.

Los Angeles Junior College offers sixteen complete curricula in this field. Dr. William H. Snyder, Director of the Los Angeles Junior College states:

"The Los Angeles Junior College is endeavoring especially to meet the needs of this semi-professional group. We are convinced, however, that the semi-professional curricula should not in any way become similar to those of the trade or vocational schools. If the Junior Colleges are to maintain themselves as collegiate institutions, they must develop in their students an orientation to the social, economic, and spiritual life of the age. This has always been the

prime function of a college education and has been attained by the study of the liberal arts. Therefore, these semi-professional curricula must contain such subjects. Because of limits of time, the academic studies offered in the Junior College must be more exploratory and less intensive than those of the four-year college. This, however, is not as a rule a disadvantage to the semi-professional students, because they are usually not academically-minded and are more interested and inspired by bird's-eye than by detailed views. Those who desire detailed work should unquestionably arrange to pursue the curricula of the universities and four-year colleges.

"In order to help in economical adjustment, the Junior College must also aid in the attainment of some skill which will enable the graduate to enter productive employment."

The engineering or technical curricula offered by this Junior College cover the fields of chemistry, electricity, mechanics, aeronauties, radio and construction. Describing the curriculum in radio and sound technology, Mr. G. D. M. Kennedy of the Los Angeles Junior College says, "Inasmuch as none of the four-year colleges offers a complete course in radio and sound, here is a curriculum that should prove interesting to high-school graduates. The first year of this two-year college course is identical with the first year of the electrical course so that the student may follow either radio and sound or electricity in the second year.

"The purpose of the radio and sound course is two-fold, namely: (1) To develop a background of mathematics, physics, and radio, so that the man already in the radio field will be able to keep abreast of new developments and improve his position, (2) to train serious-minded men who have not had experience in radio so that they will be able to compete successfully.

"This course is designed to furnish a well-rounded education that will be complete in two years. There are courses in mathematics and physics, both of which are vitally necessary to successful radio engineering. There is much work in the field of radio. There are courses in psychology and salesmanship to enable the men to meet and understand the public. There are courses in history, English, economics, etc., to develop the student's educational and cultural background.

"In other words, the course in radio and sound will (1) develop some trade skill such as servicing, testing, and repairing of radios and public address systems, and at the same time build up a technical foundation so that one may advance himself in life, (2) enable one to meet people and sell personal services or merchandise, and (3) allow one to acquire a cultural background in order to talk and act intelligently."

Speaking of laboratory facilities, he says:

"The laboratories are adequately equipped so that students may become familiar with all the fields of radio work.

"There are several different public-address systems, portable and fixed in place, which are run by students in the courses. One is located in the auditorium, another is used on the football field, and still another is used for portable work at dances, meetings, etc. Here is a first-class chance to learn public address work.

"Two low-power modulated oscillator power amplifier crystal controlled transmitters are located in the laboratory. They are equipped to broadcast either voice or signals. There are teleplex code practice sets so that the men may learn short wave broadcasting.

"In the practice booth there is a Simplex machine with sound-on-film attachment so that this phase of the radio field may be studied under actual operating conditions.

"General Radio test instruments are used for determining the sensitivity, selectivity, etc., of ratio receivers. There are six Weston receiver test kits for work on the repairing of radios.

"There is also much equipment for work with high-class amplifiers, photo-electric cells, relay, etc. In fact, there is an opportunity to learn practically any branch of radio work.

"After completing the radio and sound course, a man should be able to go to work immediately as a radio service man, ship wireless operator, public address operator, factory test man, etc. The most important item, however, is that he will have enough educational and cultural background to progress and work into a good position.

"The first course in the radio sequence is radio-physics, and it is an elementary course consisting of a short review of the principles of electricity, a study of various types of vacuum tubes, and the description of simple radio receivers. In the laboratory, work is taken up along the line of class discussion, and includes construction of the simpler type of radio test instruments and one-tube vacuum tube circuits, along with other fundamental experiments.

"The course in sound deals principally with the acoustics of auditoriums, broadcast studios, and the home. Practical applications of acoustical principles are studied, including the calculation of reverberation time, the correction of rooms, and the compensation for acoustical difficulties by means of electrical amplification such as public address systems and theatre amplifiers.

"Another course in radio-physics continues with the study of the various methods of radio-frequency and audio-frequency amplification, and includes the study of commercial circuits. The overall fidelity of various receivers is tested as well as their sensitivity and selectivity. Tests are run on various audio-amplifiers and their response to the audio frequencies is graphed.

"Another course takes up the principles of different types of transmitting by voice or signal, on the short, broadcast, and long-wave bands. In this course there is a chance to learn the code and to operate the short-wave transmitters on 20, 40 and 80 meters.

"The final course in the radio sequence deals with the commercial applications of Radio. There is a complete study of public address systems including operation. The manner of recording talking pictures and the method by which the sound is taken from the film is studied by means of the talking picture machine in the auditorium.

"Records are cut, and the attendant difficulty explained. The use of the photo-electric cell in conjunction with relays for operating bells and signals, etc., and the type of amplifiers necessary to follow these cells is thoroughly gone into. The progress of television and its possibilities for commercial applications is another angle which is discussed."

Pasadena Junior College, with a smaller enrollment, likewise offers extensive curricula in the semi-professional levels of engineering. In its announcement of technical offerings, appear the following statements:

"Broadly speaking, in the field of technical education, it is generally recognized that two sorts of curricula may be given. These divisions may be made strictly on the basis of the position in industry for which the student is preparing.

"If he wishes ultimately to work at the professional engineering level, in most cases a four or five-year engineering course beyond the 12th year is the minimum requirement. On the other hand, he may prefer to enter industry at more strictly the production level. In this case he may prepare himself in about two years by the study of intensive technical courses definitely designed to lead to employment at a level next to the professional level.

"The difference in the periods of training for these two types of technical work is from two to three years. The average earning power of the average graduates from the superior schools of both sorts of curricula is practically the same over at least the first twelve to fifteen years. The needs in industry for the graduate engineer compared with the two-year technical graduate are about one to three. These facts are causing an increasing number of technically minded students to take advantage of a two or three-year earlier start into a productive position on the technical level.

"In addition to the difference in the length-of-training period, there is a difference in the nature of the courses composing the engineering and technical curricula. The former prepare the student for further engineering courses in the university. The latter

courses are intensive and are closely correlated with each other and with the definite needs on the productive side of industry.

"The technical courses at Pasadena Junior College are on the two-year technical level and are divided into five curricula. These are mechanical technology in the field of mechanical engineering, aviation, electrical technology in the field of electrical engineering, civil technology in the field of civil engineering, and building practice and design. The definite aim of each curriculum is to prepare the student at the end of the fourteenth year to enter the world of industry and business with technical training and a developed sense of responsibility and self-reliance which will help him on to a successful career. . . .

"Building practice and design is an important field which is often overlooked by a student because a curriculum designed to prepare along these lines is often insufficiently emphasized. The student who wishes to prepare to enter the building profession, to become a contractor and designer of homes, store buildings, etc., and in general to enter with technical preparation, an industry which today has all too few properly trained men, will find this curriculum of great value.

"It should be kept in mind that these curricula in no way claim to prepare one to be an engineer. Neither do most of the thirteenth and fourteenth-year courses have any transfer value if the student later decides to enter a four-year engineering course. In order in two years to prepare the student for entrance into productive positions, the various courses must be made up of the essentials which correlate with industrial needs at the technology level. The educator or other non-undergraduate reader should note that success of the graduate in industry rather than approval of the university must be the criterion of the content, status, and success of these courses."

These curricula offerings of Los Angeles and Pasadena Junior Colleges are excellent examples of a very definite movement which is under way among the larger junior colleges in the state of California to provide technical training on the semi-professional level. In the cases just mentioned, the work is meeting with marked success and the facilities are excellent. The teaching personnel has been chosen with special reference to the experience in engineering and industrial fields; yet the development of semi-professional courses has been attended by many difficulties, and in not a few instances attempted developments in this direction have met with failure.

During the years that have marked the junior college development in the state of California, no one has ever denied the importance of providing semi-professional training; yet in spite of

the remarkable growth of the junior college in number of institutions and in student enrollment, in spite of the twenty-odd years that have elapsed since the junior college plan was organized, many of these public institutions, for a number of reasons, have continued to imitate very closely the freshman and sophomore years of four-year degree-granting institutions. They have remained fitting or preparatory schools for the upper divisions of universities, and that function of providing technical training for students whose aptitudes were of an order different from those required in the trades on the one hand and the professions on the other, has been very largely neglected.

Any student who is a graduate of a California high school is eligible for admission to any junior college in the state. While exact figures are not available, it appears probable that not more than a quarter of those who are enrolled in the junior colleges of the state would at the time of their high-school graduation have been eligible for admission to the University of California or comparable four-year institutions, and it is probable that even now at least two-thirds of those enrolled are pursuing the conventional courses of academic or pre-professional type.

So while the dual function of the junior college has been recognized by educators in this field, yet the development of semi-professional curricula has been slow for many reasons. Thus, it has been easier to teach the subjects in the traditional manner of the four-year academic college. It has been simple and relatively inexpensive to duplicate the first two years of academic curricula leading to a degree. Instructors with experience in the teaching of academic courses have been available, and suitable textbooks for these courses have been obtainable.

Again, there has been the problem of public opinion. The fathers and mothers have desired that their boys and girls go to the university, this representing the highest type of education. They have wished their offspring to secure the formal education that they themselves lacked. Higher education has been exceedingly popular. The teachers in the high schools have embued their pupils with the idea that to be a success one must achieve an academic degree.

Few have sought to show that the semi-professional occupations of industry are often quite as remunerative as are those in the strictly professional fields. Few have sought to emphasize that a man may be quite as well educated, only in a different direction, by attending a non-degree-granting institution. What those interested in education of this type need to do now is to change public opinion, taking every possible opportunity to enlighten the people, old and young, first that to-day the number of opportunities in

the semi-professional or technical fields is far greater than in the strictly professional fields; second, that there are positions of just as great importance and responsibility in the semi-professional as in the professional fields; and third, that it is no reflection upon the intelligence of a boy if he takes semi-professional work in a junior college or similar institution.

It is apparent that the standards should be just as high in semi-professional courses as in academic courses, only they should be of a different pattern or type.

The parental attitude towards education which should be encouraged is that it is an honor for any boy or girl to be engaged in work for which they have real aptitude, but that a square peg in a round hole is a tragedy. To my mind it is not only a waste of time but in many cases positively detrimental to the future success of a student who is not academically minded to attempt to force him through the four-year college leading to a degree.

With all the good that has been accomplished by our universities through higher education, I am convinced that not a little harm has been done to those who have attempted to pursue their education in the university but who have failed. I believe that many such young men who have thus been dropped from our engineering colleges have left with the feeling that they were failures. A stigma has been attached to them because they could not achieve success as measured by the university yard-stick. It might have been a different story had these same young men been enrolled in technical courses of the semi-professional type.

I know of students in my own classes who have passed through periods of discouragement and bitter disappointment, and yet later have achieved success of a high order in fields related to engineering, but not on the professional level.

Perhaps the most serious problem which faces the junior college in this movement towards the development of semi-professional curricula is that of the teacher. So long as the educational background is of academic character, the semi-professional course which he offers will not meet with success. What we need to recognize is that a fairly extended period of practical experience in the field in which the teacher is to offer instruction is a most important qualification.

It certainly is folly to expect that a teacher giving a course in building construction, for example, will be able to present the course in a way which will mean anything to his students unless he has actually been on the job, has operated a concrete mixer with his own hands, has built forms, laid reinforcement and the like. And this is an experience which cannot be obtained at any university.

Again, merely because a man possesses a university degree in chemistry, even though as a student he might have had a brilliant record in research, is no indication that his training would be suitable for some of the semi-professional occupations in the oil industry; nor does a degree in Letters and Science with a major in mathematics insure success as a teacher of surveying.

We should understand that the semi-professional occupation, as related to engineering, deals largely with the practice of an art as it is related to one or more branches of science. In conduct of semi-professional courses, while scientific theory cannot be neglected, yet it is the knowledge of the practical phases of technical work in which we are primarily interested. Therefore it appears that the teachers of semi-professional courses must be recruited from the industries. However, I believe that such teachers should have a university degree in a field allied with that of the teaching work; for example, a teacher of building construction ought to be one who is a graduate in structural engineering, but experience in the design of long-span bridges would hardly qualify him as a teacher in this field; rather, he should have had experience as an inspector, as a draftsman and as a construction foreman. It is this practical flavor which must be given to all engineering courses in the semi-professional field if they are to be successful.

In closing, I wish to express the view that for the mature student who is clearly of professional engineering caliber, the junior college is not the institution to which he should go following high-school graduation, but he should enter immediately the engineering college of his choice; for, after all, the primary function of the junior college in engineering education should be to provide training on the semi-professional level.

SUCCESS OF UNIVERSITY OF PITTSBURGH BRANCH JUNIOR COLLEGE STUDENTS AFTER TRANSFER

By F. W. SHOCKLEY

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The success of students during their junior and senior years after transfer from a junior college situation depends in a large measure on the ability of the group and the type of training they have received in the junior college. In other words, the factors of student selection and the quality of instruction in the junior college will largely determine their future success in their engineering training.

Student performance may include not only the formal requirements for admission, but also the relative ability of those attending the junior college and the "native" students with whom scholastic achievement is to be compared during their junior and senior years. Quality of instruction includes such factors as administration and supervision as it affects instruction, the training and experience of the instructional staff, the curriculum, and the tools for study—laboratories, apparatus, texts, library references, etc. It goes without saying, that, given a group of eager and capable students, good teachers, and the necessary tools for study, superior results can be attained.

Although the plan of branch junior college work established at the Johnstown Center in 1927 and at the Erie and Uniontown Centers in 1928 by the University of Pittsburgh has come to the attention of the leading institutions of higher learning of the country through the acceptance of transfer students, some facts should be restated as basic to the subject under discussion.

Students entering as freshman at Johnstown, Erie, and Uniontown are admitted by the Registrar of the University under the same regulations as those applied to applicants on the campus. While the greatest number are graduated from the high schools located in the three cities, each Center attracts freshmen from approximately 25 high schools within commuting distance of the Centers. All three Centers are located in districts having progressive school systems.

Quality of Instruction.—The administration of the junior college work is under the Director of University Extension who is immediately responsible to the Chancellor. The campus deans and

departmental heads are responsible for the supervision of instruction. The members of the University faculty resident at the Centers are chosen on the joint recommendation of the Director of Extension, the dean of the school, and the head of the department concerned. With few exceptions, all instructors have had teaching experience on the campus at Pittsburgh. They are appointed on the basis of sound training and proved ability as teachers. The curriculum in engineering is the same for the Centers and the campus. The laboratories were planned and the apparatus selected under the guidance of campus departmental heads. The same texts, manuals, references, etc., are used on the campus and at the Centers. Every effort, therefore, has been made to the end that the quality of instruction is a constant factor for students at the Centers and on the campus at Pittsburgh.

Number of Students.—The Tables below show the total number of freshmen and sophomores, and the total number of freshman and sophomore engineering students at Johnstown, Erie, and Uniontown since the establishment of the work at these Centers. It was not until the year 1929–30 that all three Centers maintained both freshman and sophomore courses in engineering. In 1929–30, of the 621 enrolled students in all schools, 144 or 23.2 per cent were enrolled in the School of Engineering; in 1930–31, 138 or 22.9 per cent of the 602 enrolled were engineering students; and during the year just closed, 95 or 21.4 per cent of the 443 students were engineering students.

Transfer Students.—A study of the tables indicates that in the consideration of the success of engineering students after transfer, we are concerned with 25 sophomores at Johnstown at the close of 1928–29, 50 sophomores at the three Centers at the close of 1929–30, and 58 sophomores at the close of 1930–31. The facts regarding transfer of the sophomore class of 1931–32 will not be known until next fall.

Of the 25 sophomore engineers in 1928–29, 17 transferred to the campus at Pittsburgh. Of the 50 in 1929–30, 33 transferred to the campus and 13 to other institutions. Of the 58 in 1930–31, 25 transferred to the campus and seven to other institutions. In total, over the period of the existence of the work, 133 have completed the sophomore year, of whom 75 have continued their engineering education on the campus and 20 have continued at other institutions. Of the 133, 13 continued their university training on the campus but transferred from engineering to another school of the University.

A study of the grades evaluated in terms of quality points made by Mr. C. Stanton Belfour, Assistant Director, University Extension Division, University of Pittsburgh, shows a slight de-

UNIVERSITY OF PITTSBURGH BRANCH JUNIOR COLLEGES

Total Enrollment

	1927–28			1928–29			1929–30			1930–31			1931–32		
JUNIOR COLLEGE	F.	S.	T.	F.	S.	T.	F.	S.	T.	F.	S.	T.	F.	S.	T.
Johnstown	164		164	190	100	290	125	116	241	146	107	253	99	81	180
Erie				102	13	115	164	54	218	127	109	236	97	78	175
Uniontown				110	4	114	84	78	162	68	45	113	45	43	88
Total	164		164	402	117	519	373	248	621	341	261	602	241	202	443

Enrollment in the School of Engineering

	1927–28			1928–29			1929–30			1930–31			1931–32		
JUNIOR COLLEGE	F.	S.	T.	F.	S.	T.	F.	S.	T.	F.	S.	T.	F.	S.	T.
Johnstown	28		28	37	25	62	31	18	49	27	24	51	32	13	45
Erie				19		19	43	11	54	32	25	57	21	14	35
Uniontown				23		23	20	21	41	21	9	30	8	7	15
Total	28		28	79	25	104	94	50	144	80	58	138	61	34	95

cline in the average number of quality points earned during the last semester (second semester of the sophomore year), and a still further decline during the first year after transfer (first semester of the junior year) to the campus at Pittsburgh. The average quality points earned during the two years after transfer exceeds the average for the first two years. The experience of students whose official records have been obtained, who transferred to other institutions, parallel that of students who transferred to the campus. In brief, it can be said that the small group under consideration continued with a slightly better average during the two years after transfer than during the first two years. The author appreciates that, because the study includes the experience of so small a group over such a short period, no conclusions should be drawn.

As a group, the transfer students continued in their junior and senior years a quality of work quite similar to that attained during their freshman and sophomore years. Students showing superior ability in their freshman and sophomore years have continued to do superior work after transfer. At the recent commencement, of the 110 men graduating from the Schools of Engineering and Mines, two of the three students who graduated with honor took their freshman and sophomore work at the Centers, one at Johnstown and one at Erie. At the previous commencement, one transfer student graduated with high honor and two with honor.

Total.....	28		28	79	25	104	94	50	144	80	58	138	61	34	95

TECHNICAL INSTITUTE EDUCATION IN A COÖRDINATED SYSTEM OF ENGINEERING EDUCATION *

By ROBERT HOOVER SPAHR

General Motors Institute of Technology

Institutions throughout the world including the ones in the United States are being challenged. Perhaps, never before has the searchlight of scientific analysis been so sharply focussed upon our own more or less loosely jointed educational, sociological, and industrial structures. It is hoped that the debris of shallow and uncalled-for controversies is being cleared for better unified and planned programs of action.

These structures are of necessity intertwined and dependent each upon the other. Developments under each have changed and will continue to change environments; environments, in turn, affect human behaviors and relationships and create a diversity of needs. As adjustments changed less rapidly in times past, so the needs, likewise, changed less rapidly. *Natura non facit saltum.* Organized plans to supply these needs, whether for education or for industry, are becoming more and more a necessity.

When planned changes are substituted for evolutionary changes, we need the leadership of foresighted men with ability and with the knowledge and training to think through situations and meet them with adequate plans. We need men of capacity and force to translate these plans into action. We need a vast army of trained men to develop and carry out details. In addition, we need men who are successful followers as well as successful leaders. It is but logical that we look to our educational and training systems to supply a large part of these requirements, in the fulfilment of which engineering and technical education must have an important part.

If the requirements of our immediate period were education only for the technical professions or for research and advanced forms of analytical design, one general type of school might serve the purpose fairly well. This condition does not prevail, however, since a relatively small number of the present engineering graduates follow strictly professional lines or are engaged in advanced forms of theory and research; not more than one in ten as an optimum would classify in this latter group. Every study or analysis indicates a

* Presented at the 40th Annual Meeting of the S. P. E. E., Corvallis, Oregon, June 29–July 1, 1932.

wide variety of positions requiring educated and trained men, from the group leader to the chief executive and from the trained technical worker to the most highly developed research man.

Positions in business and industry which originally required men with a good hunch or a pleasing personality are finding themselves manned at present with individuals who have little understanding of modern scientific principles and applications; such individuals do not believe in these principles because they do not understand them; theirs is an understanding of another day. The trends are apparent; the handwriting has appeared on the wall. Likewise, the schools and colleges which do not use foresight and plan for these needs as indicated by the experience of hindsight deserve to meet their respective fates.

The purchasing agent in industry, for example, will have to deal intimately with least-cost purchase quantities as will also the man in production planning. Others will be called upon to figure the point beyond which additional repairs for machinery and equipment are not justified. In each of these functions, at least an elementary use of the calculus is employed effectively. Men must also consider the economic effect of materials handling, and the various balancing factors applied in modern management; these are all positions in which until recently little consideration was given to technical and mathematical analyses. Even the usual production foreman, formerly a "rule-of-thumb" man, needs to understand economies obtained through more scientific rate setting, as well as time and motion studies, and he must know the workings of intricate costing systems. These responsibilities, as a general and practical policy, can no longer be entrusted to untrained men. Indeed, many other examples of changed status and widening responsibilities might be enumerated.

The four-year engineering college in the United States has done a creditable job; the wonder is that it has done so well, considering all factors. For many phases of work, there can be but little question as to its effectiveness; and, it will continue to occupy a prominent place in our educational system, provided of course, that it does not permit itself to become static and thereby neglect the ever-changing needs of the employers of men as well as the changing needs of the men themselves.

We have assumed, somehow, that courses of the same length, four years, of practically "standard" content, taught in largely the same way, should supply all of these needs equally well. Is this a correct assumption?

If four is the right number of years to prepare for all kinds of positions in business and industry, if the content of the usual engineering program is the right kind for a wide diversity of em-

ployments as well as for the varied bents of individuals, then it would be criminal to confuse the issue by proposing a more widely diversified program; it would complicate rather than clarify.

On the other hand, world experience together with data evolved from numerous studies indicates the definite need for a wider diversity of facilities for technical education in the United States; particularly is this true in the great present industrial areas and in the areas with fair indications of becoming industrial. Diversification may also be carried to excess, thus causing a blurring of aims and a lack of united effort.

Assuming that the case is fairly clear for an expansion of facilities, what direction should this expansion take? Before we may discuss intelligently the place of the technical institute, or the type of education given in technical institutes, in a coördinated program of engineering education, we must arrive at some understanding as to what kind of program it should be. Naturally, the more nearly ideal program would be that which would serve most adequately the needs of the employer, the employee, and society.

If experience as chief engineer in manufacture, some years in teaching and in administration in engineering colleges, the representing of American business and industry in connection with train-

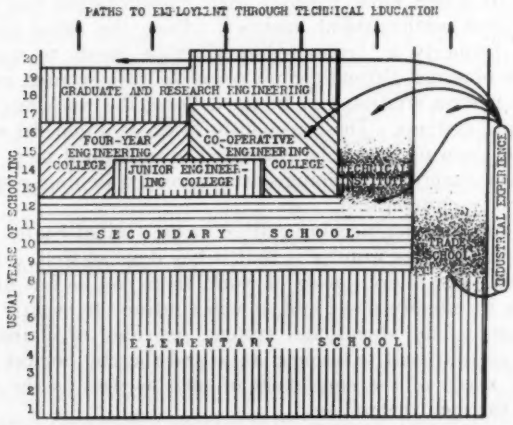

FIG. 1. Vertical paths through technical education in the United States.

ing needs, active connection with the studies of the S. P. E. E., and more recently the studying of the educational and training requirements of a large corporation qualify one at all, perhaps I may be pardoned for attempting to set forth briefly as a premise the needs, as I see them, in a general coördinated program of engineer-

ing education. For the sake of clarity, the *type of education* instead of the *type of institution* will be referred to most frequently.

An analysis of the present and near future needs seems to indicate three general areas of engineering and technical education, above the high school level, (1) graduate and research, (2) undergraduate or the usual four-year engineering, (3) technical institute or semi-professional. The numbers of students in these areas should be in the order given, the first having the least and the last the most.

For certain positions in business and industry, particularly in advanced forms of research and technical development, the usual four-year engineering course is little more practical than would be the usual science course for advanced forms of research in chemistry or in physics. Research is assuming an increasingly important rôle in many industries; in fact, the continuation if some industries and the advent of others depend upon the results of research. This should mean that some of the very best four- or five-year engineering graduates should continue in school one year and others should continue two or three years, along lines of concentration and specialization.

To meet these needs, there should be a relatively small number of graduate schools of engineering, science, and research, located in strategic centers, adequately equipped and manned for work *par excellence*.

The most comprehensive studies in both the educational and industrial fields indicate that from eighty to ninety per cent of the needs for four-year engineering graduates from the colleges have been supplied already, under normal business conditions. This is assuming, of course, that these graduates will go into positions of a general technical nature only. However, there is a growing appreciation that an engineering course may equal any other course in general educational or cultural values, a fact long suspected by many. This is vividly shown in the Pennsylvania studies, Fig. 2. The trend throughout the country is definitely in the direction of generalization in the undergraduate engineering courses as against specialization, and this will tend, also, to increase the popularity of engineering courses as general education media.

The four-year engineering college will continue to occupy an important place in a program of technical education; on the other hand, it is generally conceded that the present number, about 150, in the United States is ample to care for the needs. Perhaps, some of these engineering colleges would not be missed, yet to abolish, transform, or merge many of our small but effective engineering schools, as is sometimes suggested, would in my opinion be disastrous; rather, they might well be supported and strengthened.

There are large numbers of boys entering our four-year engineering colleges who by reason of their characteristics and bents might profit far more in some other type of education, and thereby relieve the present congestion and enhance the effectiveness of the entire program. These estimates as to the needs appear to hold true for some years to come, even in the light of the expectation that the popula-

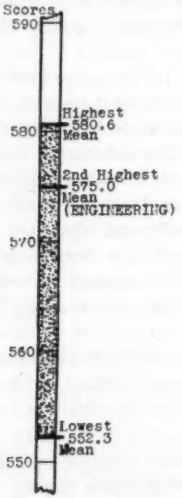

FIG. 2. Means of the total achievement test scores by selected curricula in fifty Pennsylvania colleges.*

tion of the United States will continue to increase during the next two decades at least. Apparently, the needs are not for a larger number, but for better four-year engineering colleges.

In considering the four-year type of engineering education, we cannot overlook the work of the junior colleges, so well described in other papers at this meeting. Within a decade, almost out of air, have sprung a hundred or more educational institutions offering two-year courses in engineering, or perhaps more accurately pre-engineering, giving almost exactly the first two years of the usual four-year engineering program—courses intended primarily for entrance into the advanced years of the engineering college. There are now indications that these junior college programs will become more diversified to meet better the local requirements as time advances.

* Through the courtesy of the Carnegie Foundation for the Advancement of Teaching.

The remaining part of a coördinated engineering education program, and the largest in numbers, should logically be supplied by technical institute education, sometimes called semi-professional education.

The technical institute and the area of education which it represents have been rather fully described in papers before and in reports by this Society. Few technical institutes per se exist in America at present, but the type of education is found in a variety of institutions including the junior colleges, the newest source and perhaps one of the largest potential fields for the development of this type of education.

The results of technical institute education both here and abroad have been studied and appraised. Various "yardsticks" have been applied impartially. Comparisons have been made with four-year engineering education; not being the same, they may not always have been exactly comparable, but since the graduates of both types start in practically the same positions, certain comparisons may be indicative.

The starting salaries of the two-year graduates from one of the better known technical institutes average slightly above the graduates from the combined four-year engineering colleges; for the first fifteen years after graduation, the average earnings of the two are about even; beyond fifteen years the number of technical institute graduates is too small to be conclusive, but there is an indication that beyond that period the balance may favor the four-year college graduate. The average earnings of the one-year technical institute graduates fall below those of the two-year men and, of course, below those of the four-year men, but nevertheless they make a good showing.

The positions in industry held by the institute graduates compare favorably with those held by the college graduates. About 1 in 81 engineering college graduates in the technical, supervisory, and managerial positions in manufacture was president of a plant; on the other hand, of 5,261 technical institute graduates tabulated, 96 were presidents, or 1 in 55. An analysis of thousands of cases indicates that the expectancy of becoming a president of a manufacturing company, based on the education had, is in this relative order: graduates in mining and metallurgy, civil engineering, non-engineering college, chemistry and chemical engineering, mechanical engineering, technical institute, unclassified engineering, and electrical engineering. The data indicate further that a technical institute graduate has about three and one half times the chance of becoming a company president as does a four-year electrical engineering graduate.

The reactions from the technical institute graduates have been

rather definite and to the point. Their expectations have been met to a remarkable degree, and they would follow the same course had they to do it over again.

Certain factors, aside from the instruction process, may have influenced results for the technical institutes. The student enters

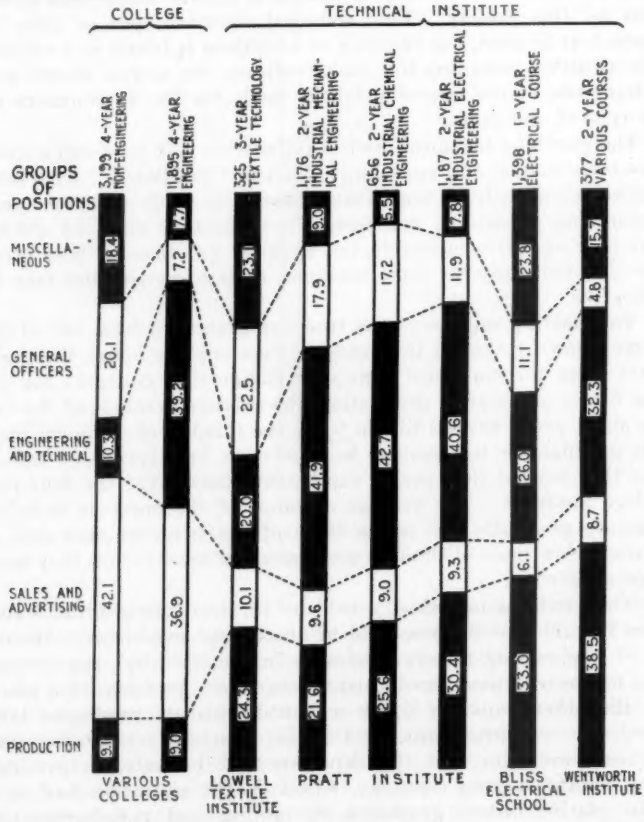

FIG. 3. Distribution of technical institute and college men in employment.

the institute with approximately the same scholastic preparation, at least in quantity, as does the engineering college student; the selective process is less standardized, therefore more adaptable and frequently more searching, than the same process in the college; on the average, the student is more mature than is the college student,

and he frequently has worked for a period previous to entrance. He, perhaps, has been attracted by the more practical and direct methods of instruction, and, in addition, often has a seriousness of purpose not found in a number of college students who have had less to do with the stern realities of life. Assistance by the school in locating the right kind of employment after graduation may also be reflected in their records, and assistance rendered the graduates in later years may be another factor in their showings.

Only certain of the findings of the study have been reviewed here for the purpose of recalling the results which are apparently possible through technical institute courses, which courses, at present, vary in length from one to three years. Indeed, some of us four-year engineering graduates may find it interesting and maybe a bit embarrassing to account for those "additional" years in our college careers.

A large field of need for the technical institute type of education appears to be to educate and train men in the technology of particular industries, widely and successfully practiced abroad. The American Institute of Laundering is an example in the United States. Other needs appear to be for specific courses in electrical and mechanical technology, aeronautics, technical sales and services, and other "terminal" courses for the thousands of positions in industry not requiring four-, five-, or seven-year courses; the technical institute type of course might be further developed in business, merchandising, banking, applied art, civic health, and similar fields. It is said that the banks of Los Angeles alone have about four hundred open positions each year; as a result of this analysis, the representatives from the banks of that city have planned with the Junior College a terminal curriculum to prepare for these positions. After all, the needs of the community should determine the variety and the kind of educational offerings; until we know more accurately the needs of the respective communities it is a matter, more or less, of uncertain speculation. Comprehensive local studies must determine community needs.

In the original report of the study of technical institute education it was estimated that the manufacturing and mechanical industries, not considering the potential fields mentioned earlier, could absorb effectively from 40,000 to 50,000 technical institute graduates annually. These estimates and conclusions were recently discussed and reviewed by the writers of the report, and in the light of present trends no sound or logical reasons were seen for changing them. The estimated number of technical institute men required annually for new and replacement positions is approximately five times the number now being graduated annually from the four-year engineering colleges. Since the national study has been completed,

at least six local studies have been made, and in each the conclusions as to the needs for technical education have verified those from the original.

Another type of need has appeared on the horizon; it seems to be chargeable largely to our technological development. It did not appear as a major need at the time of the original technical institute study, but it bids fair to become an important one in the near future.

Notwithstanding the withdrawal annually of 50,000 to 75,000 students, sixteen years of age and over, from the normal ranks of the employed by reason of the increased popularity of schooling, it is becoming increasingly more difficult for a high school graduate of eighteen to obtain employment; the employment age at the lower end of the work life is moving upward; in a similar manner, the age of retirement, voluntary or involuntary, is being pushed downward. The latter affects the problem of schooling only indirectly; the former is serious. What is the boy to do between his graduation from high school at eighteen and the "expectancy" age at which he may find satisfactory employment? The vast majority of these boys cannot and perhaps should not enter the usual four-year college; the college is planned and directed toward serving the more brilliant or academically minded. The average high school graduates, more than 300,000 each year to say nothing of the thousands in the lowest scholarship brackets, will be left to shift for themselves, and that, for many, practically means loafing. Each college year finds that from 50,000 to 75,000 are not adapted to the college courses or that the college courses are not adapted to them, and some of these, too, just a year or two older, join the ranks of the 300,000. This is a sociological problem which fairly staggers the imagination. Further education for these young folks, waiting for an opportunity to work, has been suggested. Naturally, this means the need for a wider diversity of post-secondary educational facilities. Several states appear to be moving in the direction of technical institute or semi-professional education in order to aid in meeting this problem.

The present college or university is organized and prepared to care for the academically inclined, the top strata as far as marks are concerned in the high school graduating classes; this is an important assignment, yet only a relatively small percentage of the high school graduates is served. Technical Institute or semi-professional education, too, has a responsibility to care for those in the top strata, who, for various reasons, may wish to study fewer than four years, those who for financial reasons are compelled to consider the briefer courses, and, in addition, a vast

number of our future average citizens—many of whom are practically inclined and would profit more by the shorter course.

Facts justify the conclusion that no four-year college or university should attempt to operate technical institute courses parallel with the four-year courses on the same campus and under the same faculty; the chances against success are too great. However, with proper autonomy and physical separation, there is no experience or reason to assume that technical institute education may not be successfully given in a branch or coördinated part of a college or university. In fact, there are arguments in favor of such a coördinated program of engineering and technical education. Our state universities, for example, might consider serving the industrial centers of their respective states more effectively by branches or through some form of coöperative arrangements in these centers.

The Technical Institute of the University of Wisconsin at Milwaukee, the branches of the Pennsylvania State College, and certain work at Rutgers University are typical examples of beginnings in such a development. The branch of the University of Pittsburgh at Johnstown, Pennsylvania, has been pointing in this direction. The Armour Institute of Technology in its plan of development is contemplating a college of science and engineering, an industrial research institute, and a technical institute as coördinated parts in a comprehensive educational institution.

Intelligent plans built upon known facts are the best insurance for success in establishing technical institute work. Results in technical institute education and training will always depend largely upon the attitude of the administration and faculty. If the administration and faculty want the school to be a technical institute, it will be that, with ample demand from prospective students; on the other hand, if they want it to evolve into a college, it will be just another college, also with ample demand from prospective students.

The junior colleges in certain geographic areas may be expected to develop the technical institute or semi-professional courses to a very much larger degree than they have to the present.

From the Sacramento (California) Junior College—

"This institution has offered a terminal course in engineering drafting since 1928. It has attracted very few students and only three have completed the course and entered the semi-professional engineering field. There seems to be no call among the entering freshmen students for terminal courses."

From the Los Angeles (California) Junior College—

"Since there was an attendance of 1,132 semi-professional students

when college closed in June, 1930, these courses seem to be making a strong appeal to the young men and women of the city who are not academically minded and who do not desire to spend four years in college, but who feel the need of adjustment beyond that which could be given by the high schools."

The rapid growth of the junior colleges, particularly in certain sections of the country, will make it necessary to prepare many of their students for life or direct employment, and it is generally assumed that a terminal course of two years is preferable to the first two years of the usual engineering course for effective employment. Certain difficulties of two- and four-year programs when operating parallel are eliminated under the junior college organization, since practically all of the courses in this field are two years in length. But, the danger still remains that the faculty might consider the preparatory type superior to the technical institute or semi-professional type of education, and if so the students will be sure to sense their feelings in the matter. Such feelings might be the result of previous training, tradition, unfamiliarity with the direct type of teaching, or through a lack of intimate knowledge of the results and characteristics of technical institute education.

The most successful work in this area of education at the present time emanates from the institutions operating per se as technical institutes. They have years of experience and some tradition back of them. Several of the institutes have very definite aims and adhere to them rather closely. Their teaching staffs are stable, and there are relatively few new instructors at any one time. Other educational institutions will have the utmost difficulty in duplicating the results of the better technical institutes for various reasons, including the lack of teachers trained and experienced in the intensive and direct methods largely used. The chances for best results are with the institution organized and run as a technical institute, free from all distracting influences; yet, the largest opportunities for growth and development may come in connection with the four-year colleges and as integral parts of junior colleges. The latter development means that careful study and sound planning will have to be exercised or disappointment will be inevitable.

The technical institute type of education has justified itself in the eyes of its graduates and in the estimations of the users of its product, and thereby should recommend itself to thousands of students who possess bents and inclinations in this direction. The needs for the technical institute type of education in business and in industry have been shown. The indications are that it should supply by far the largest number of technical men of all the types of engineering and technical education. Its place, in general, in

a technical education system is intermediate between the trades and the professions. The major sources of supply will be technical institutes, junior colleges, four-year colleges, both public and private, and perhaps in some instances super-structures built upon technical high school programs. The public institutions may be expected to furnish the bulk of technical institute education, whereas the private institutions may be in a more favorable position to render valuable contributions through experimentation.

Before it will be possible to have a united and really effective engineering and technical educational system, certain factors must be faced and considered. Perhaps certain of our personal views may have to be adjusted in order to blend in with the composite; intolerance may have to give way a bit to tolerance. Public opinion has been influenced by published figures and pictorial representation showing the money value of a four-year college education, and the boy from the time he entered kindergarten has been told of the bag of gold dangling from the college degree; on the other hand, little data have been available until recently to show the value of a one-, two-, or three-year course, measured by similar "yardsticks."

A mania for degrees has developed, in far too many cases the desire for the degree taking precedence over the desire for the education. Those completing satisfactorily the four-, five-, and seven-year post-secondary programs receive degrees; those completing satisfactorily the one-, two-, and three-year programs receive what is termed a diploma. The former authorizes the recipient to place after his name certain letters of the alphabet—symbols; the latter confers no such authorization. Apparently, the diploma graduates into a full-fledged degree somewhere between the third and fourth years. Both, however, indicate that the holder has completed satisfactorily a course of study at some educational institution. If this degree has attained such influence and prestige as to affect the efficient administration, operation, and popularity of courses of different lengths, stamping one as superior and another as inferior and therefore less to be desired, then some plan should be evolved to eliminate as far as possible these undesirable factors.

Two courses of action have been suggested, neither one quite complete in itself nor without highly controversial elements: either discard degrees altogether, or if they are essential give them without favor and discrimination in respect to the number of years required. True, such degrees must not be the same, and they must not duplicate the accepted practices any more than a B.S. and an M.S. duplicate each other; these stand primarily for different normal lengths of courses—a measure of quantity, not necessarily

of quality. Perhaps, the most compelling reason why the two-year graduates might be authorized to publish the fact, by the use of certain symbols after their names, that they, too, have completed certain amounts and kinds of work satisfactorily is that the four-, five-, and seven-year men are authorized to do so. There is already a precedent in this direction; a two-year degree has been given, namely, the A.A. (Associate in Arts); thus, an A.E. (Associate in Engineering, paralleling somewhat the practice of the membership grades in the professional societies) and others in corresponding fields might be a solution.

For a coördinated engineering and technical education program to function successfully, it is apparent that there must be no distinctions, creating impressions of superiority or inferiority for the different types and lengths of courses, particularly since the different types are for different objectives, and the different lengths do not necessarily indicate different quality.

In a junior college, where the technical institute or semi-professional type is offered parallel with the preparatory type, both, perhaps, should receive the same credentials, in the same way that the bachelor's degree is given in various fields of study. The Los Angeles, California, Junior College is experimenting in this direction.

Closely akin to credentials is the transfer-credit, another problem, which, if there is to be an effective and successful coördinated program, should be faced frankly and fearlessly. Engineering or pre-engineering transfers from the usual preparatory type of junior college course are practically upon the same basis as from one college to another college. Perhaps, relatively few from the technical institute or semi-professional courses will seek transfer-credits in the four-year engineering colleges, but what about those who may find it advantageous to continue their education? Should outstanding students from the technical institute be encouraged to continue their studies as in other types of education? If so, where may they continue them with the least lost motion?

Scattered data throughout the study indicated that the stronger four-year engineering colleges were more liberal in evaluating and granting credit for technical institute work than were the weaker colleges. There is work in the technical institutes which in kind and quality should not be counted in transfer-credits toward an engineering graduation anywhere; on the other hand, there is work in some of the four-year engineering colleges which, too, in kind and in quality never should be credited toward graduation. Transfer-credits serve two major purposes, namely: substitution for local graduation requirements and as an indication of adequate preparation for more advanced studies. Both presume to indicate

that certain knowledge and development have been acquired by the student.

It is recognized generally that the semester-hour of credit does not represent equal amounts of knowledge and development in two individuals; the Pennsylvania Studies present rather astounding findings as to the spread of knowledge and development among

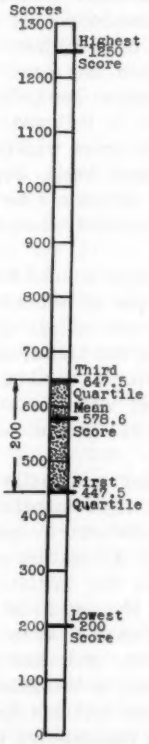

FIG. 4. Spread of total achievement test scores made by senior engineers in one Pennsylvania college.*

college men in the same school, in the same course, and in the same class—all candidates for the same credentials, Fig. 4. Might this not indicate the possibility that many technical institute men may possess knowledge and development in certain basic subjects, such

* Through the courtesy of the Carnegie Foundation for the Advancement of Teaching.

as mathematics, superior to that had by many college men who have followed these subjects many more hours in their curricula?

In the final analysis, does it matter where or how the student obtained this knowledge and development, whether from a college, from a technical institute, or through personal studies, so long as he has thoroughly acquired them?

No institution or a department in an institution or an instructor in a department has a divine monopoly of the one best method of teaching or of the content of a subject.

As diversity of education increases, the more frequent use of local evaluating or examination methods and the less frequent use of transfer-credits will, it is believed, bring consistently better results; individuals coming from widely diversified fields of education would be on a fairer basis, depending more upon their tangible mental assets. It would not be a move of least resistance, however, but one with immensely constructive and valuable possibilities.

The faculties of each type should know more of the aims and objectives of the other types of education, and this applies more particularly to the four-year college faculties. Of the types of education and training in the technical field, the least is known about the technical institute; its methods and results need elaboration and dissemination, as well as do the possibilities of semi-professional education in the junior colleges. Out of knowledge comes understanding.

The following statement was made in the technical institute report: "Some means of closer association seems greatly needed. Whether it should be a distinct division of the Society for the Promotion of Engineering Education or an independent body is not clear. In either case the initiative should come from the directors and teachers of the technical institutes themselves."

Suggestions in this direction have come. The junior college development, entering both technical institute and engineering college fields, adds emphasis to the importance of a clearing house for information. The time which a few others and I have been able to give the numerous requests for information and services in connection with the terminal course field coming from technical institutes, junior colleges, engineering colleges and other educational agencies has been entirely inadequate, considering the importance of these developments.

It appears that the time has arrived when coördination is essential for the best interests of engineering and technical education in America. Personally, I am of the opinion that the time has arrived when the S. P. E. E. must decide whether it will continue to serve well the 150 four-year engineering colleges only, or whether

it will proffer its leadership, services, and influence to the 100 junior colleges which are offering in some instances both preparatory and terminal engineering programs, and the relatively isolated technical institutes.

Technical institute education may be expected to grow. The needs have made that clear; its results appear satisfactory; the results of the future will depend upon the soundness of the new developments. Indeed, much will depend upon the ideals and the foresight of its leaders. The vast needs have proved tempting for exploitation in a few instances; in several others, consideration was given to the organization of institutes with uncertain or inadequate funds back of them.

It is a rare exception that an institution in the post-secondary field of education has operated on a self-supporting basis and given first class instruction. It might as well be recognized generally that adequate funds are just as essential in conducting successfully a technical institute as they are for a college. The institution operating on a "hand-to-mouth" basis and depending entirely on an income governed largely by the ups and downs of business conditions or upon periodic or voluntary contributions must, with few favored exceptions, pay the penalty; it seems that this is inevitable. Continuity and stability beget quality and loyalty on the part of the faculty, students, and alumni; the best teachers naturally avoid connections of insecurity and uncertainty. The principles and practices of speculation, chance, and even human relations in business and industry are not the "common law" principles and practices in the college world; the school which chooses to transgress accepted ethics becomes an outcast. It becomes, therefore, a duty to warn against unsound or over-zealous developments.

The technical institute, by reason of its close interests with business and industry, has an excellent opportunity to capitalize and utilize further the interest, experience, and coöperation of business and industry, the future customers for its product, without sacrificing autonomy or being unduly influenced by transient needs. This is an opportunity that has been woefully neglected, with few exceptions, by the four-year engineering colleges. The responsibility here clearly lies at the door of the administration of the engineering colleges.

Coördination, acquaintanceship, coöperation, leadership, the recognition of facts, and, last but not least, tolerance are elements which should go to make up an effectively coördinated engineering education program.

ENGINEERING AND TECHNICAL EDUCATION AT THE PASADENA JUNIOR COLLEGE *

By ARTHUR G. GEHRIG

Instructor in Engineering

In discussing the features of the Engineering and Technical Education at the Pasadena Junior College this paper must be considered as only a progress report of the work we are attempting at Pasadena.

The program for engineering students who are going to complete the regular four-year course at a standard university has been offered for the past four years, but the two-year course for the technical students who expect to go directly into employment at the end of the fourteenth year has been offered for the first time during the past school year. Therefore the thirteenth year work only has been given. Next year both the thirteenth and fourteenth year work will be offered.

The Pasadena College is a combined four-year institution embracing the two upper years of the traditional high school and the two lower years of the regular university. Its enrollment is approximately 3,600 students, divided about equally between these two groups. The Pasadena College District includes an area of 125 square miles, a population of 100,000 people, and an assessed valuation of nearly $160,000,000. Although Pasadena is not an industrial community it is a seat of scientific learning and lies just at the edge of a metropolitan area which has two million population and considerable industrial and commercial importance.

The engineering program was launched four years ago. Prior to that time no attempt was made to prepare the engineering student for full junior standing in the university. The only engineering subjects offered were descriptive geometry, engineering drawing, high school surveying, and high school shop. The next step was to inaugurate those engineering subjects which were shown as required subjects in the lower division curricula of the standard colleges. These included plane surveying, astronomical surveying, materials of construction, structural drafting, heat power engineering, elements of electrical engineering, mechanisms, engineering problems, and materials and processes.

* Presented at the 40th annual meeting, S. P. E. E., Corvallis, Ore., June 29–July 1, 1932.

To parallel the lower division curricula of the four leading colleges in the state (University of California, University of Southern California, Stanford University, and California Institute of Technology) at once created a fair sized educational problem. Fortunately the task has been lessened in two ways: first, by the universities simplifying their own curricula, and second, by their very helpful attitude in accepting some subjects which are required by one or more of the other universities in lieu of some in their own curricula.

This helps the junior colleges to have larger classes, fewer subjects, and more effective results. This type of coöperation by the universities is very much appreciated by the junior colleges, and I am sure results in a much better training for the students. This spring marks the completion of the four-year engineering curriculum by our first students who had a junior college engineering program. Definite statistical reports from the universities indicate clearly that our students have done well in carrying on their junior and senior work. As our courses, methods, curriculum arrangements, and student material improve we hope that our engineering transfers will make even better records in their university work. Some say they will continue with specialized graduate work.

The problem of offering a technical program two years beyond the high school leading directly to employment at the end of the fourteenth year was confronted two years ago by the appointment of a committee consisting of the director of industrial arts of the city system, the chairmen of the manual arts department, the mathematics department, the physical science department, and three instructors who were then teaching engineering students. This group studied S. P. E. E. reports, technical institute catalogues, local needs and possibilities, and visited several schools near Los Angeles and in the Bay Region.

The committee then set up tentative plans for building and equipment, curricula, faculty needs and qualifications, and student entrance requirements. These were rapidly put into effect and the two year program definitely launched in the fall of 1931, with about 80 thirteenth year students in the five curricula which had been provided, viz., Aviation (36), Building Practice and Design (10), Civil Technology (12), Electrical Technology (10), and Mechanical Technology (12). It will be noted that nearly half of the students elected the work in aviation, the other four curricula receiving about equal portions of the remaining students. No particular attempt was made to guide the students into one branch or another, although perhaps this should be done in the future. It was largely a matter of their own selection, and of course aviation seemed to be popular.

In making provision for the physical plant the one-story portion (about 80 per cent) of the old manual arts building was razed to the ground and a new structure erected on the old site. The new structure is approximately 100 ft. by 200 ft., has 20 ft. clear story, and saw-tooth roof construction. Sub-floor, bricks and skylight glass from the old building was used in the new. This building program cost about $55,000. New equipment costing about $57,000 was installed. All of this $112,000 outlay is primarily for the technical program as the four-year engineering student has very little time for laboratory work in the two years at junior college.

Of the $57,000 spent for equipment almost none was used specifically for aviation, or building practice and design, and none for surveying or hydraulics in the field of civil technology. The bulk of the budget was used for a very complete electrical laboratory (about $22,000), a materials testing laboratory (about $13,000), a heat treating laboratory and a machine shop. Some of the old woodworking equipment was retained from the old manual arts shops; while practically all of the aviation equipment was borrowed or secured gratis from the government and private companies.

The subjects and curricula in these five fields of technology were selected and arranged entirely independent from university precedent and without regard to any university transfer value. The criterion in each case being immediate and dependable value in employment. The students are told plainly that these courses are designed and taken for use and not for "credit." If they are capable and wish to take the standard four-year university course they must start in it from the beginning and not hope to swap horses in mid-stream.

At the end of the first year's trial we are nine months older and naturally wiser,—both faculty and students. If confessions and testimonies are permitted some of our difficulties and remedial measures may be mentioned.

To affect the new organization a year ago the manual arts department was disbanded, the engineering work was transferred from the mathematics department to the physical science department, and the technology work added to the physical science department; forming in effect a large department of physical science, engineering and technology. Next fall the organization will be readjusted in such a way that the engineering work will be returned to the mathematics department, and a new department of technology established.

Our laboratories were laid out on the open floor principle, without walls or partitions; but already wire fences have been

put up, V. & C. V. partitions added, and barricades of work benches and gates constructed.

The first group of students for this work is far from the standard desired for this type of intensive work. From thirty to fifty per cent of them are deficient in desirable personal traits as well as in specific subject prerequisites. Both of these disadvantages will be reduced we believe with the next incoming group. However, it is hard to control the matter of prerequisites, for although we give the eleventh and twelfth year work on our own campus, 75 per cent of our engineering and technical students come from other schools. Just as quickly as possible the entrance requirements should be brought up to the proper standard, for as long as a low standard is tolerated through expediency, some very good students will fail to be attracted to the work.

At the earliest date practicable the entrance requirements for this two-year technical work ought to be just as high as those for the four-year engineering student; and this applies to English as well as mathematics, chemistry, physics and drawing. The technical student with so much to do in two years can not afford to be handicapped in any way. A junior college attempting work in the true field of technology must ever be alert to keep its subjects, students, faculty, and facilities distinctly above the trade school level.

The matter of counseling or orientation is a very potent factor in securing desirable results. Up to the present time our students were assigned to seven counselors entirely on an alphabetical distribution, but next year one counselor will be designated to confer with all engineering and technical students. He is making it his first duty to become thoroughly familiar with all phases of these two allied fields, and to set up some arrangement (possibly placement exams or technical aptitude tests) by which students in this work may be more intelligently selected for the various types or branches of engineering and technology. There is much to do in this direction, but if some solution is found it will surely be of tremendous value in selection and guidance.

In a limited number of courses this year we had mixed classes; that is, engineering students and technology students in the same class attempting the same type and quantity of subject matter. It is the opinion of all of the instructors directly concerned that this situation should be avoided at the earliest possible date. In our schedules for next year we are planning almost no mixed classes.

There is a definite need for a new type of text book for this work in technology. With the exception of a very few subjects, suitable texts for this level of work are not available. The grow-

ing importance of this field of education should be a challenge to both authors and publishers. Good books exist for the technical high school or trade school, and also for the university; but equally good texts for this intermediate level are badly needed.

In selecting new instructors for this work the administration has given full consideration to the actual needs of industry, and sets qualifications higher than would be imposed upon engineering instructors. Minimum preparation includes an engineering degree, five years recent actual practice in the field to be taught, and three years of teaching experience. Four new men were added to our faculty for this technical program.

Continuous contact with industry and practice through faculty odd-time employment, class trips, technical associations, and student employment is to be encouraged to the fullest extent. Even though our students have now completed only the thirteenth year quite a few satisfactory placements were made this spring, especially in the aviation industry.

It is planned to have an advisory committee from industry for each of the five curricula offered, but this detail is not functioning yet.

If the customer is to be the judge, we have been fairly successful this first year, for almost every student is well pleased with the opportunities offered, is earnest in his work, and intends to return next fall.

On the whole we are not at all discouraged at the end of the first year. We are quite convinced that there is a large opportunity in this type of education where the community can afford the cost and where there is a demand for the product. It surely should not be attempted in the smaller junior colleges for it requires a lot more equipment than the first two years of the engineering course, and would be a failure without instructors who have had actual practice in the various fields.

Details of equipment, technical curricula, and engineering curricula are given in the Technology Catalogue and in the *Engineering Magazine* (a student publication) which are here for distribution in a limited quantity to those most interested.

As to the relationship of the two-year technical education to the standard engineering colleges, it would seem that if it provided an effective training for the 65 per cent of the students that usually drop by the way before graduation, it would save the engineering colleges a great deal of crowding and trouble, provide industry with a large number of specifically trained technical men, and save society a considerable expense and disappointment.

SEMI-PROFESSIONAL ENGINEERING EDUCATION

By DEAN FRED E. AYER

University of Akron

This paper embodies the recommendations made to the Municipal University of Omaha after an educational survey made there in February of this year. The topic will be discussed under the headings:

The Need for Semi-Professional Education
Previous Proposals
Plan Recommended for Omaha
An Idealistic Dream

The Need for Semi-Professional Education

By a semi-profession in this paper is meant: "An occupation in order to enter upon which one should prepare himself with a course of training approximately two years in length, with a high school education or its equivalent as a prerequisite." *

By means of check lists sent to men qualified to judge in their particular fields, Professor Koos found occupations classified as semi-professional as follows:

Commerce group, 14
Agricultural group, 12
Engineering group, 43

The following are ratios of technical institute men to four-year college men desired for effective operation by the industries of New Jersey:

Separate Studies	Ratio—Technical Institute Men to Four-Year College Men
Study No. 1—48 Manufacturing Companies	2.8 to 1
Study No. 2—21 Manufacturing Companies	2.7 to 1
Study No. 3—Public Utilities of New Jersey	2.7 to 1

Various checks were applied to these findings. A study by Thomas of the numbers of positions believed to require two and four years of college training respectively in twelve corporations in California was examined. When these figures were compared, on the same basis, the ratio of the positions needing two-year men to four-year men was 2.6 to 1.

For another check, the technical "positions vacant" in the New York

* "The Junior College and Training for Semi-Professions," by Professor L. V. Koos, of the University of Minnesota.

Sunday Times, over a period of several months, were tabulated and classified according to positions believed to require two and four years of engineering training respectively. This resulted in a ratio a little less than 3 to 1.*

There are at present approximately one fiftieth as many technical institute men in manufacturing as the employers say they should have. An annual output of from 15,000 to 20,000 technical institute men could probably be annually absorbed in manufacturing alone. Less comprehensive estimates from the public utility and transportation industries demands in proportion.

Evidence is conclusive that industry is under-recruited with technically educated men. This condition applies particularly to areas of technical education other than the four-year engineering college.

Thousands of positions do not require four-year college men; to place college trained men in them would do injustice to employers and employees alike.

Many men would prove mediocre or even fail if subjected to the usual engineering college learning methods, not always due to absence of ability, for they frequently show outstanding capacity to learn by more direct methods; this immense potential capacity should be developed. Other thousands of men can neither afford the time nor the money to undertake four-year courses; for these, opportunities should be available to capitalize their abilities for themselves, their communities, and their country.*

In the report of President W. E. Wickenden on his study of technical institutes in Europe, published in the S. P. E. E. JOURNAL, September, 1931, he says:

The needs of the country could scarcely be met by less than 250 institutes, and seem to call for the creation of a great chain of community institutions having an organic place in city and state educational systems, yet free to achieve their own distinctive character.

. . . . . .

The same industries estimate the desirable quota of employes having approximately two years of training above the secondary level at from 6.0 to 8.3 per cent of their total forces. At present this potential demand is not more than one-fiftieth supplied and an output of from 25,000 to 30,000 graduates a year from technical institutes could be absorbed to great advantage.

. . . . . .

The coöperative plan, based on alternating periods of school work and industrial employment, seems particularly well adapted to the aims and the levels of age and work of the technical institutes. The plan has marked advantages in the training of supervisors of production, operation and maintenance—men who begin in overalls and rise by a ladder

* R. H. Spahr, General Motors Institute of Technology, in Proceedings of Tenth Annual Meeting, American Association of Junior Colleges, Atlantic City, N. J., November, 1929.

which passes through foremanship to superintendance and ultimately to management. It affords the student a valid trial of aptitude and a normal orientation to industry without necessitating a break in the continuity of education. The coöperative plan eases the economic burdens on both the student and the school. It should be pointed out, however, that the coöperative plan does not obviate in any large degree the need for extensive scientific and technical equipment; in fact the demands on equipment in a technical institute are fully as intensive, if somewhat less varied, as in the engineering college.*

In continental United States there were 13,787 A. S. C. E. members in 1931, 17,377 A. S. M. E. members in 1930, and 15,214 A. I. E. E. members in 1931, a total of 46,738. Using the ratios given in Mr. Spahr's paper, this total indicates a need for from 117,000 to 140,000 engineers with semi-professional training. These figures disregard chemical, metallurgical, and mining engineers, and the many others not represented in the three societies used. Therefore, it does not seem an exaggeration to estimate that there is a real place in our industries for 200,000 engineers with semi-professional education. That this need is very inadequately provided for is obvious to all educators.

Previous Proposals

Engineering educators have long recognized the need for semi-professional training and the desirability of modifying our system to provide periodic terminal points. In Volume XVI, 1908 of the *S. P. E. E. Proceedings,* Vladimir Karapetoff, Professor of Electrical Engineering, Cornell University, proposed a curriculum under the title "On the Concentric Method of Engineering Education." His curriculum introduces engineering subjects in the freshman year and continues them throughout the course, narrowing, specializing, and intensifying as the student gains mastery of the scientific tools of his profession. He illustrates by a chart of concentric circles entitled "Concentrically Widening Students' Mental Horizon."

Mr. Spahr, in his paper previously alluded to, quotes as follows from the catalog of the General Motors Institute of Technology:

> The first two years have been organized to provide training of such a nature that the student who ends his course at the end of this period may be prepared immediately for work of a technical nature, and in some cases for skilled mechanical, or minor supervisory positions.
>
> Attention has also been given in the organization of the curriculum for the first year in order to provide the student ending his course at this

* Summary Report of A Study of Technical Institutes by The Society for the Promotion of Engineering Education, June, 1931.

point with a well-rounded training, of practical value, for employment in mechanical, operating, and, in some instances, detail drafting work in the plants.

An attempt on the part of the engineering colleges to provide both types of training meets with some very practical difficulties. The first of these is the student himself. Once he has decided upon an engineering career, the best is none too good for him, therefore, he embarks upon the course leading to a degree. We engineering educators have not made it possible for him to complete a semi-professional program of engineering training which would also include the prerequisites for the professional one. Furthermore, neither the student nor the engineering college can tell whether or not the high school graduate has the intellectual capacity for the higher level, or the intelligence and practical ability for the lower. As the engineering curriculum now stands, the student must choose between the technical institute and the engineering college. If he chooses the institute, he can not go on to the college without much loss of time. If he chooses the college, he is not prepared for any kind of engineering work at the end of two years.

Plan Recommended for Omaha

A few years ago the writer experimented with a curriculum which commenced with the third year in high school. Enough progress was made to indicate its practicability, therefore, last year, Mr. L. A. Hartley, formerly Director of Education for the National Foundrymen's Association, worked out a detailed curriculum based upon the requirements for graduation from Akron high schools, the admission requirements of the University of Akron, and the engineering degree requisites in the latter institution. This curriculum provided semi-professional engineering training for two full-time years in high school and two half-time, coöperative years in the University of Akron. It satisfied the requirements for graduation from high school and entrance to the University at the end of the regular high school period, and also allowed the student properly qualified at the end of this four-year, semi-professional training period to complete the engineering degree course in three more years. (The coöperative engineering course is five years in length.)

The curriculum satisfied both the demands of semi-professional education and the prerequisites for the degree course by shifting the distribution of subjects between high school and college and by changing the order of some of the college courses. Shop work, mechanical drawing, English composition, trigonometry, surveying, mechanics, and at least part of inorganic chemistry were

included in the high school part. In the college, calculus was postponed until the third year and strength of materials, hydraulics, machine design, electricity, etc., were to be taught without it. The calculus, when taught, was to include the derivation of formulas already used empirically in the aforementioned engineering subjects.

Obviously, such plan would not have been recommended for Omaha unless the University and the public schools had expressed their interest in it and their willingness to coöperate in carrying it out. The plan recommended contemplates teaching trigonometry in the high school and solid geometry in the college if the latter is taught at all.

Of 111 institutions reporting, 67, or 60 per cent, require solid geometry for admission to their engineering courses, while only 15, or 13½ per cent, require trigonometry. This suggests my second question: Would not trigonometry be a better entrance requirement than solid geometry?*

. . . . . .

Whatever may be the value of solid geometry as preparation for other engineering courses, I think there can be little doubt of its relative worthlessness as preparation for college work in mathematics compared to the value of trigonometry. At Dartmouth College we do not require solid geometry for admission, nor do we teach it in the college. We have never felt the need of it anywhere in our mathematical courses. The space figures which need consideration in the calculus seem to offer no special difficulty, and instruction in solid analytic geometry proceeds smoothly without previous preparation in solid pure geometry.*

Would it not a more logical arrangement to teach only plane mathematics in the secondary school and reserve the solid mathematics for the college?

An objection will probably be raised to the teaching of engineering subjects (strength of materials, for example) before the student has attained mastery of the calculus. An analysis of any modern textbook on strength of materials shows that with the exception of the derivation of the formulas for bending moment, torsion, moment of inertia, and radius of gyration, there is practically no calculus required until the problems in deflection are reached. These formulas can wait for proof until calculus is reached and then their derivation will enhance the realization of the utility of the subject.

The advisability of placing some of the engineering subjects in the secondary school may also be questioned. Such procedure

* "The Adjustment Between Secondary School and College Work in Mathematics," by John W. Young, Professor of Mathematics, Dartmouth College, S. P. E. E. JOURNAL, Vol. XXII, No. 7, March, 1932.

will have two distinct advantages. It will be an extra incentive to the student who has inherent capacity for engineering work and will discourage the unfit one before he leaves high school. It will also help to decrease the duplication of high school work by the college.

The departments in which the college offers considerable work classed as secondary, taking both amounts and percentages into account, are English, most of the foreign languages, chemistry, and physics among the sciences, history, art, music, and the engineering and industrial group.*

The amount and proportion of repetition for all subjects is shown in the lowest row of figures. On the basis of the assumptions as described, the latter turns out to be 14.9 per cent. However, owing to the conservative character of most of these assumptions as pointed out in explaining the table, *the actual repetition of materials can hardly be less than a full fifth of all the work taken in the high school by such a group of students. This is the equivalent of four-fifths of a high school year. Even after allowance is made for some measure of review to add to the fixation of fundamental skills accomplished only by means of extended drill, what remains is a big price to pay for attempts to divide secondary education between two separate institutions.**

If there is a 20 per cent duplication and slightly more than half of it, 11⅑ per cent, can be eliminated, then one complete year in a combination four-year secondary and five-year college course can be saved. Whether such result be viewed in terms of time saved, money saved, or increased ground covered, it is certainly an objective worth striving for.

An Idealistic Dream

Up to this point an attempt at least has been made to keep within the realm of the safe and sane. What follows is doubtless academic heresy and should not be hearkened to by any self-respecting educator (educationist, or educationalist, take your choice).

It is obvious that the dual arrangement between the high school and the college here proposed for the Municipal University of Omaha and the Omaha high schools will never be adopted extensively in other cities no matter how successful it might prove there. But if it does prove advantageous it may stimulate similar endeavors in junior colleges and state universities. It is the dream of the writer to see a state system of education in which semi-professional education on a coöperative basis is provided in all the business and industrial centers through the medium of junior colleges

* "The Junior College," by Leonard Vincent Koos, Ph.D. Published by the University of Minnesota, May, 1924, Vol. II.

with a curriculum arrangement coördinated with the state university providing for the last three years of the degree course in the latter institution. These last three years would also be on the coöperative basis with alternating periods of quarters or semesters so that the student could continue his outside employment in his home community. Such a program could readily be operated, for example, in states like New Jersey and California.

As further proof of the "Red" tendencies of the author (though probably none is needed) it is his firm conviction that the differential is in front of the radiator cap in our whole system of professional education. The mature mind of the educator proceeds naturally from the general to the specific. He grasps a broad fundamental truth and is able without difficulty to see its multifold applications and variations. Therefore, he plans his professional curriculum, both required and prerequisites, from that viewpoint. The engineering student must cover prerequisites in language, mathematics, science, etc., throughout four years in high school, then he must spend two years more in further preparation in college, all with the promise, of finally, after six years, being given some instruction in engineering. This in face of the fact that the great majority of all actual engineering calculations can be made with no deeper foundation than that of arithmetic, trigonometry, and mechanics. Under such conditions, it is not strange that only forty per cent of engineering freshmen graduate; the miracle is that the percentage is so high.

As educators we seem to have overlooked the fact that the immature mind proceeds from the specific to the general, grasps a number and variety of applications, and then is capable of tying them together in a general law. When such an one decides that he wants to study engineering, he is not content to wait four or six years before he starts. An analysis of the subject matter in the curriculum of training for any profession, whether it be law, medicine, engineering, or what-not, will show that a very large proportion of it is NOT dependent upon four to eight years of previous education. Then why not start it earlier and give the more scientific subjects as they are needed?

At once the objection is raised that such procedure involves a choice of vocation too early in life. This objection is really not nearly as serious as we have been wont to believe. In the first place, an early start in the study of a profession is perhaps as good from the standpoint of general education as the present diffusive and aimless general training, and in the second place, how important is it that the average person choose just the right vocation? In other words, how serious is this "square plugs in round holes" complex which we have read so much about in recent years?

Several years ago the writer picked out about fifty names of people who had been written up in a well-known magazine specializing in biographies of the famous and successful, and wrote them asking whether they believed they could have been as successful in other lines of endeavor. The list included a minister and a ball player, an engineer and an author, a cook and a professor, etc. About thirty replied and all but one were perfectly sure that they could have succeeded equally well in several other vocations, and many of them were pursuing, creditably, avocations widely divergent from the activity which brought them into the spot light of this particular magazine. It is very probably true that the average person can do equally well in any one of many vocations. We need not worry about the genius, he will naturally gravitate to his particular bent.

In conclusion, while we are questioning nearly everything else in education, why not question the sequence of subjects? Perhaps interest may be increased by opening the service with the benediction.

DISCUSSION, "MODERN TRENDS IN ENGINEERING"

Charles Derleth (University of California): I have been told that I might speak five minutes. What can I add to all this wisdom displayed these past forty-eight hours? We have had stimulating addresses from General Rees and Dean Kimball. We are, I am sure, strongly in accord with their viewpoints and ambitions, yet each has emphasized a different trend for the vehicle of our accomplishments.

Your program committee requested me to discuss the subject "Business and Administrative Aspects of Engineering"—the announced title of Dean Kimball's paper. But, yesterday, when I received from Dr. Kimball his manuscript it was headed "Whither Engineering?" One might enlarge on this and say, "Whither Life?' I am beginning to think that this is not a society of engineering educators or administrators; this seems to be a society of philosophers.

I feel a certain pride in being allowed five minutes to speak to you. I trust General Rees will not misunderstand my remarks. I agree heartily with his plans looking toward the future, but let us beware of too much regulation. Surely we will all agree that Plato had a profound intuition. He too had a plan. It was not entitled "Whither Engineering," or "Whither Life." His plan in the "Republic" concerned "Whither the State." He devised curricula in a large number of very inclusive departments. There were certain men and women to be trained to procreate the state; others were to be instructed specifically to be soldiers and fighters, statesmen and politicians, farmers, artisans, philosophers, and the like. Yet mankind apparently has not so far selected that type of State.

At critical times people sometimes train themselves. England at the time of the opening of the Crimean war developed the personality of a Florence Nightingale. I think she studied few curricula that brought about her tremendous influence upon society. Her relatives practically disowned her as a woman who was not following the precepts of the Victorian age for a lady. She entered the tumult, went into the Balkans, and against opposition tried to bring succor to the butchery there. She returned to England a physical wreck but with a spiritual ideal that built the modern conception of hospital nursing and treatment. What curriculum had she satisfied? Leaders and experts are not made by complex curricula.

All of our great improvements have not come from previous

planning. We have today curricula for women, called "home economics." I imagine an enthusiast would want these women to have a very intensive course in engineering, because of so many electrical contraptions in our homes which are always getting out of order and are costing poor husbands so much money.

Yes, we are all considering coördinated education in engineering, and in everything else, and with a vengeance. We are discussing today, it seems to me, a coördinated life, and I hope none of us are forgetting that we are all differently endowed at birth. Even if we were equally endowed, we are different in taste and in our opportunities, and in our faith. You can manufacture a top, you can wind it and it will spin, but after that the child must keep on spinning it.

We have been discussing the problems of the university to train apprentice engineers, and we also have in mind the necessary training that that individual later should receive from industry, or from whatever vocation he seeks to follow. We likewise have in mind what he, himself, must do in self training.

I sometimes wonder, as I digress here, Dean Kimball, whether it really is necessarily true that there are not going to be fundamental inventions in the immediate future. We do not know. I think of Maxwell who, in one of his very fetching papers toward the close of his life, said he was happy he had lived in that particular period where physics had given the final solutions to the riddle of the universe and had established the details upon the foundation which Newton had built. Yet within twenty years of Maxwell's death we had x-rays, airships, the radio, electrons, protons and Einstein. There is a relativity in our affairs. We are looking through a kaleidoscope. Some of us are turning it one way, and some another. We all see beautiful pictures, though they are different. Yet they are all related.

Professor Kimball, in one of our recent journals, has listed among the ever increasing numbers of curricula a proposed course in "administrative engineering," and if I mistake not its emphasis is upon that training which ha has so ably defined as necessary for management in industry. A wide outlook, too, is needed for the free lance consulting engineer who is so rapidly becoming almost extinct.

In a nearby city on this coast the people were misguided into voting recently that they would not have disposal of garbage and refuse at sea, or by cut and cover. They were led to vote on a technical question that they did not understand, and decided that they must have an incinerator. The garbage collector group said the incinerator would not work. After twenty years it has been discovered that it does not work. Perhaps it could if it had a

chance. Very recently that city selected prominent and competent health officers, doctors, and sanitary engineers, men doubtless who had had almost a seventeen years' course in some university. These men will never solve the problem if they merely restrict themselves to the purely technical aspects of that problem. The real question at issue is to find someone who knows about medicine and health and engineering who will be able to go through the back doors and ramifications of the society in that city and bring together the boss Italian at the head of the refuse group, the leaders of certain downtown associations and improvement clubs and cause them to put their heads together to find out how it may be arranged so that the refuse collectors will still have their job and the city still get certain technical improvements. It requires a man of wide public interest and insight who understands the psychology of human nature. Have we a curriculum for him?

Are we to say that every technical school in this country must, perforce, develop long series of curricula and require every individual student, man and woman, no matter how endowed, to pursue these curricula? It cannot be done, as I said yesterday.

I might give many examples. You can give them, too.

There is another great city on the Pacific Coast that wants to build the longest and perhaps the greatest bridge in the world. It can get easily the best engineers in the country to design deep foundations and long-span cable super-structures; and yet it may never build a bridge unless it can do what? Bring the community, the interests behind ferries and behind local and suburban railroads together into a program with a financial structure that will cause them all to work together in harmony and have some of them willingly lose something at the same time that the community as a whole benefits.

Who is to be the city's leader? He may come from any group of people. He may never have seen a university. Therefore, in conclusion (and I know I am speaking too long), it is my conviction that we should say "Amen, and God bless you," to these schemes for planning. Let us have them. But let us be on our guard lest we destroy an elastic educational structure, whereby we have junior colleges and high schools and technical institutes, night schools, and correspondence courses, as well as universities and graduate research departments. All have their place. Like an army, or like any other group, we must not train all our engineers to be generals or bank presidents. We need leaders, officers; but we need also a great many privates; our inspectors, timekeepers, surveyors, cost accountants, etc., who more and more must be men who are specially trained. They too are in a position of trust and responsibility; they must be trained; but not till they are old men.

We want an elastic organization. I am one of those who believes firmly in change, but also that we should be slow to give up a tried institution. I think a great majority of those who have been found fitted for advanced instruction still should not have more than a four years' engineering curriculum, and it should consist essentially of fundamentals in science and technology and not of general subjects.

Our engineering institutions of the future should give opportunity to the selected few who have completed a four years' undergraduate instruction and let them stay a fifth and even a sixth year, not necessarily for degrees; men who see the wisdom and who have the time, the money, the purpose and the capacity to do more than just fundamentals. Let them blend the pure science fundamentals in application to thermodynamics, strength of materials, mechanics, electrical, mechanical and civil engineering.

Above that, you can still have more graduate instruction and research both in the university and in industry and in after life for any men who have the vision and the capacity to do unusual things. We should study until we reach the grave, those of us who get anywhere. And those who are found lacking are those who do not know how to lead themselves. It is folly to insist that we shall have a uniform system of instruction of great intensity and complexity which shall be followed by everybody. Therefore, I say in conclusion that what we want is an elastic structure in our school and university systems. It is well if different schools are different. Variety is the spice of life. We must be careful lest by too much planning we get too much uniformity, no initiative, too much restriction, state and federal regulation, too much registration, and still more planning.

H. S. Rogers (Oregon State College): This discussion is indeed very intriguing. I seem to be unbounded by the topics which have been covered by previous speakers. The widest range is most certainly open to me in a discussion of this paper and the comments made upon it.

Does not the previous discussion suggest that we are turning our attention rather from the field of engineering itself to the field of thought of the engineer? We are beginning to philosophize upon his thought processes. We are looking in toward his mental activities. Is it not time for us to get a quantitative picture, if possible, of what engineering is in its way of thinking, of how it is differentiated from that thinking which the philosopher does from that thinking which the scholar of arts and letters does, of how it is characterized by its one dominant quality, the application of generic principles to the constructive solution of problems?

After all, engineering is characterized by its purpose and by its

processes. The discussion which we had night before last in the Council meeting on what research should be and what requirements should be necessary for a graduate degree, brought up very clearly, I think, the fact that one who in engineering is to obtain a graduate degree should make some new application at least, some creative application of the great generic principles of engineering.

Is it not true that one trained in any branch of engineering, for example, one who has become a master of civil engineering, founded as it is pretty largely upon applied mechanics, applied to solids, and applied to liquids, understands what all other engineers are doing by the process of analogy, although he may not understand the fundamental principles which they use?

Our great problem in engineering education, is, therefore, to preserve those elements in our program which are distinctive and characteristic of engineering? Are these not embodied in the group of courses which constitute the training men must pursue in order to master fundamental principles of mechanics, electricity or heat and to understand their application to the constructive solution of problems?

Certain portions of all curricula, whether they be organized one way or another, I think is immaterial. A certain fundamental backbone of each curriculum must be maintained to develop that particular type of thought and to emphasize the constructive application of engineering principles. After we have done this, we have opportunity for developing at least some orientation in the approach to the administrative and business aspects of engineering.

I doubt very seriously if we can accomplish what we feel necessary as the distinctive part of an engineer's training and do very much in the field of administration in four years. Certainly, however, when young men are plastic, when they are receptive to new ideas, when they are seeking orientation we should give them that orientation which is necessary to direct their attention and their thoughts toward the problems of business and administration, so that as these are encountered in their engineering practice and experience after graduation they will be able to assimilate their experiences in an orderly and recognized manner.

A year ago last fall I was riding from Cleveland to Pittsburgh with a bishop of the Episcopal Church. He was telling me about his work in Kenyon College, an Episcopal seminary in Ohio, and he was telling me about his desire to influence the young men in that seminary. He said he had three great objectives: one, to see that they were thoroughly schooled in their theology and in the canons of the church; one, to see that they were indoctrinated in the viewpoint of the church; another, to see that they lived devout and Christian lives.

I began to laugh and he said, "What is humorous about that?"

I said, "The humor of that, to me, is that that is the picture I have drawn for myself of engineering education: a mastery of some field of engineering principles and practice, recognizing the limitations, of course, in the mastery of practice; a discipline in devout engineering lives, that is in the methods and habits which characterize engineering thought; and a viewpoint of engineering with relationship to industry and economics, and the social structure as a whole. That is exactly the same picture which you have been describing to me."

Now I wonder if that is not the picture we will find in every form of education: a mastery of the tools and of the practices; a discipline of the personality and of the individuality; and the philosophy of service of that particular profession. We have gone fairly well along our course in the first two. As soon as Dean Derleth began talking this morning I knew we were making progress in the third in the philosophy of engineering thought.

C. E. Magnusson (University of Washington): Dean Kimball has made a notable contribution to the proceedings of this convention by presenting in almost slogan form ideas that bring into bold relief important trends and developments in the engineering field. On page three of the typewritten copy of Dean Kimball's paper it is stated: "Engineering appears to have become a *method of thinking* or rather a *method of accomplishing results* in a manner never before known to mankind."

A *method of thinking* or a *method of accomplishing results:* either form may well be considered an epitome of the essential nature of engineering education and in a measure the whole engineering profession in America. For we use the word engineer not only as a *noun* but also as a *verb*. We engineer a business deal, a political convention, a bill through Congress and, in fact, almost any enterprise. We even engineer a dance or a revival.

To engineer, a method of accomplishing results, means essentially the same as to manage, but under one very important qualification—*it must be done successfully*. To engineer implies the gaining of the desired objective—that is, a successful method of accomplishing results. We never engineer a fiasco.

Engineering, as a noun, is a field of study, a profession, or the art and science of utilizing natural resources. However, Dean Kimball stated that in essence engineering is a *method of thinking,* and in this I heartily concur. Assuredly a *method of thinking* is the core, the essence, of engineering education. The value of four years in college is not measured by the mass of information accumulated by the student, but by the power acquired to think logically in engineering terms, that is, mastering the engineering method of

accomplishing results. It is of little moment whether or not the graduate can readily integrate a differential equation without referring to a book, but it is of vital importance that he shall, not only understand the calculus notation, but be able to think of practical engineering problems by the calculus method. The rapid routine of solving equations can to best advantage be acquired on the job, but the *method of thinking should be gained in college.* This, I take it, is the fundamental reason for set courses in engineering curricula. In set courses, or fixed curricula, the process of training students in methods of thinking is the main objective, while comparatively little time and effort are expended in the mere accumulation of information. By means of fixed curricula we have kept that which the colleges of the arts and sciences long ago lost by the ruinous elective system. From the first day in the Freshman year, in a properly constructed engineering curriculum, to the final senior examination, every course stands for a definite purpose—in fact, forms an element in the *engineering method of accomplishing results* that should be acquired by the student when in college. The freshmen taking algebra are advised that to secure a satisfactory grade at the end of the quarter is merely a side issue, that the algebra must be mastered in order that it may be used later as a tool; that a good working knowledge of algebra is essential, not only in the other courses in the curriculum, but also in professional work after graduation. Similarly for physics, chemistry, calculus, mechanics, alternating currents and all the required courses—the laws and principles and methods are mastered in order *to be used* in the more advanced courses in college and in professional work after graduation. The curriculum is not merely a set of mental hurdles to be cleared, but the laws and principles and methods of thinking covered by the curriculum are mastered for use, not only in college but throughout life.

Dean Kimball notes with apprehension the probable permanent decrease in demand for engineering graduates in our industries on the basis that the rapid industrial expansion, which during the past three decades created an ever increasing demand for technically trained men, will not be resumed in the future. While it is highly probable that the rate of expansion in our industries will decrease, this need not necessarily result in a lessened demand for trained engineers. The engineering colleges can ovrcome the decreasing demand in the industries by expanding their markets. As a matter of fact, this expansion is well under way. In this morning's session Dean Kimball asserted that 75 per cent of engineering graduates in the United States are, even now, in executive work; superintendents, managers, presidents, some position or other, in which the work is largely of an administrative character.

This means that the market for the output of engineering colleges has expanded; that already a large number of engineers have gained highly responsible positions in fields for which they had no direct training in college; that the engineering method of thinking, the engineering method of accomplishing results is a winner in fields far remote from engineering proper. Most assuredly more engineer-superintendents and engineer-managers are needed. Remember the verb *to engineer* means to direct, to handle, to operate, to manage *successfully*.

A short time ago I discussed organized research with the Director of one of our large research laboratories. On the personnel phase he made quite a point of the fact that practically all the men in direct charge of research problems in his organization were physicists, not engineers. Here is an occupational field open to engineering graduates. For I am strongly of the opinion that no better undergraduate preparation for future research-physicists can be found than the regular four year course in Electrical Engineering. Moreover the future calls not only for engineer-physicists but engineer-chemists, engineer-mathematicians and even more for engineer-economists and engineer-statesmen. In fact there is an urgent need for the engineering method of thinking, the engineering method of accomplishing results, of successfully gaining desired objectives in many fields besides engineering. I believe that the training in quantitative logical thinking as given in regular engineering curricula would, in very many cases, be the best possible, not only for engineers, physicists and chemists but also for future economists and financiers.

The world is emerging from the *machine age* during which the efforts of the engineers have been directed almost exclusively to the design, construction and operation of machinery, and entering on a new era, the *engineering age*, in which the engineer will come into his own, in which the engineering method of thinking, the method of accomplishing results will be the outstanding characteristic in many important fields of human endeavor.

THE YOUNG ENGINEER AND HIS ENGLISH *

By ROBERT I. REES,

Assistant Vice President, American Telephone and Telegraph Company

When I accepted Professor Hammond's invitation to talk to this group on the subject "The Young Engineer and His English," I resolved that I must obtain substantial supporting evidence for any opinions I might express to you. Generalization from a few striking instances is too frequent and too easy in dealing with such a topic. Even sharp criticism of teaching methods and their results often rests on no more secure a foundation. Precise measurements may be impossible but it is not impossible to obtain fairly objective judgments from a representative group of individuals who are in intimate contact with the problems this subject implies.

There is, of course, some evidence of this character already available. The investigation of engineering education conducted by this Society a few years ago obtained the opinions of over 500 members of engineering faculties and several thousand graduates in engineering, concerning the importance of training in English. In brief, over 95 per cent of the faculty members considered English Composition to be of primary importance as a fundamental element in all engineering curricula. English Speech was thought of primary importance by 75 per cent, and English Literature was so considered by 45 per cent of these men. Two-thirds of them, moreover, thought that courses of purely cultural value should be *required* in engineering curricula and half of them recommended Literature as an especially valuable element in their cultural content. Although the graduates ranked cultural subjects last in importance after those of a scientific, technical and economic character, over 60 per cent of that group thought them indispensable or of considerable value. One-quarter of these men believed that more attention should be given to English in college. A similar proportion were continuing their study of it after graduation.

These data conclusively support the general opinion that English training is of major importance to the young engineer, and at least suggest that more emphasis should be placed upon it in the engineering curricula. They do not indicate whether the engineering graduate has been handicapped in his work by inadequate

* An address delivered before the English Session of the Society's Summer School for Engineering Teachers, The Ohio State University, July 26, 1932.

training in English and, if so, how that training might be strengthened. Further evidence on these and similar points seemed most desirable, and it is this which I have attempted to secure. In doing so, I have drawn upon three groups of men: (1) about 400 engineering graduates less than five years out of college, now employed in the several Bell System Companies; (2) about 90 supervisors of such men, who come into intimate contact with their work; (3) a few Deans of graduate schools in which both engineering and other college graduates are enrolled in some numbers. In the case of the first two groups, rather formal questionnaires were submitted, permitting tabulation of the replies, but individual comments were also invited. From the Deans, only general statements were requested.

Care was taken to have the graduates replying to these questionnaires representative of all such men in our organizations, rather than selected men of above average ability. We believe, however, that there is some evidence which indicates that they are above the average of their college classes. In the case of the supervisors, however, we endeavored to select men likely to be especially discriminating and thoughtful in their replies.

The Point of View of the Recent Graduate

The specific results of the questionnaire to recent graduates were as follows:

Question 1: Please enumerate the definite uses which you have in your work for written or spoken English, indicating about what proportion of your working time is spent in those particular activities.

Answer: About 25 per cent of the working time of these men is spent in preparing letters, memoranda, reports, and other written material. Slightly over 20 per cent of their time is spent in contacts with the public or with their supervisors and other employees of the Company. Naturally, these proportions vary in individual cases, but on the whole, it is evident that in the Bell System, young engineering graduates spend nearly half their time in work which requires the use of written or spoken English.

Question 2: Has the preparation of letters, memoranda, and written reports been more difficult for you than other phases of your work?

Answer: Nearly 40 per cent of these men replied in the affirmative, and slightly over 60 per cent replied in the negative to this question. That two-fifths of them should find their written work more difficult than other parts of it is hardly surprising. I am not certain we should not find similar results even among a group of teachers of English.

Question 3: Have your supervisors found it necessary to revise, not the facts or reasoning of these letters and reports, but the way in which your thought was expressed? If so, has this occurred (*a*) frequently, (*b*) occasionally, (*c*) seldom?

Answer: About 10 per cent of the men stated that frequent correction of their written material was necessary; somewhat over 50 per cent stated that it occurred occasionally; and rather less than 40 per cent said that it

occurred but seldom. On the whole, this seems encouraging, as we may judge that only a relatively small proportion have serious difficulty with their written reports. In some cases too, corrections by supervisors may be arbitrary or based on formal rules; in any event, certain of the graduates feel that this is true.

QUESTION 4: Do you find it difficult to express your ideas orally in individual conferences with your supervisor or in group conferences?

ANSWER: 30 per cent of the men replying answered in the affirmative and 70 per cent in the negative. The number of men who find this sort of expression difficult is rather less than in the case of written work. My feeling is that this percentage may be more disturbing than in the former case.

QUESTION 5: Do you feel that college graduates in Arts and Science or Business Administration are able to express themselves more easily and effectively than you are (*a*) in writing? (*b*) orally?

ANSWER: In the case of both writing and speaking, slightly less than half the men felt inferior to the Arts and Science or Business Administration graduates, with slightly more than half feeling no such deficiency. Many of the men too, stated that this was probably due to the types of men who undertook the different college curricula, rather than to the content of their college courses.

QUESTION 6: Would you favor more emphasis on English in the engineering curriculum? If more emphasis is to be given to English, do you believe that more time should be devoted to definite instruction in (*a*) composition? (*b*) speaking? (*c*) literature?

ANSWER: 90 per cent of the men answered the first part of this question in the affirmative. Something over 80 per cent favored more emphasis on composition, and a slightly larger proportion favored more emphasis on speaking. Only 25 per cent, however, felt that more time should be devoted to literature.

There is a clear demarcation here. Evidently the engineering graduate believes in pursuing the thing which he is after directly, and is skeptical of the incidental values which literature might bring him. For my own part, I am not sure that range of vocabulary and quality of style can be gained without more contact with great literature. If I should be correct in this, a distinct challenge is presented to the teacher of literature in engineering schools to arouse his students to an appreciation of its worth.

QUESTION 7: To what extent do you feel that effective results could also be obtained by stressing better writing and speaking in classes other than English?

ANSWER: About 13 per cent of the men replying felt that no, or very little value could be gained in this way. Half of them expected some value from it, and the remainder expected a good deal of value. It is interesting to compare these results with the decidedly frequent suggestion from the supervisors that this method of attack would be decidedly worthwhile.

QUESTION 8: Do you believe that the quality of instruction you received in English at college was as high as that received in your technical subjects?

ANSWER: Slightly more than half of the men answered "yes" to this question, but nearly half felt that they obtained better instruction in their technical subjects. Here again, the question of major interest on the part of men pursuing engineering courses comes into play. Many of them, with less interest in the subject of English, may feel that the caliber of the instruction in it is not high.

QUESTION 9: Was there any tendency at your institution to regard English courses as of minor importance (*a*) on the part of the students? (*b*) on the part of the faculty?

ANSWER: Nearly 90 per cent of the men agreed that the students considered English courses of little importance, but less than 30 per cent felt that the faculty had shared this opinion.

QUESTION 10: Please describe your own attitude toward its importance when you entered college, during your senior year, and at present.

ANSWER: The answers to this question throw a good deal of light on the replies to the preceding one. A large majority of the men said the English seemed of little importance during the freshman year; that by senior year its importance had become apparent, and they now feel that it was very important indeed, in fact approaches their technical work in importance.

QUESTION 11: Please give any general comments you may have concerning training in English for engineering students, which have not been covered in the preceding questions.

ANSWER: A large proportion of the men desire that more emphasis be placed on the importance of English by faculty, alumni, and business men with whom students come in contact, in order that they may recognize, during their college course, the need for devoting more attention to it. The implication is that these men feel they have missed something which they could have gained if they had only had a somewhat different point of view during their college course. In fact, some of these men felt that English should be taught during the entire four years and that, if necessary to accomplish this, the engineering course should be lengthened. Many different opinions were expressed concerning changes in the methods of teaching English to engineers. One suggestion was that English should be taught by instructors directly connected with the engineering department, who would then have more understanding of the interests of engineering students. On the contrary, another man suggested that the examinations in engineering subjects should be corrected both by engineering professors and English professors, for errors in expression. Some men feel that the trouble has been in the English preparation obtained in high school. Others favor special courses in letter writing and many suggest such courses in public speaking. One man believed that the cultural side of English should be stressed in order to develop the habit of wide reading. Another man suggested that a course in English should be given in the senior rather than in the freshman year, while still another man felt that the training in English could best be obtained through courses pursued after graduation. A wholesome warning against over-emphasis on the importance of English was voiced by one man who agreed that it was important, but secondary in value to "accuracy and truthfulness."

In general, the replies of the young engineering graduates in the Bell Telephone Company of Canada paralleled those of the men in the United States very closely. Somewhat higher percentages of the Canadians, however, were skeptical of the quality of the English instruction there, and believed that it was considered of minor importance by both faculty and students. Their supervisors, on the other hand, were quite as well satisfied with their use of English as those in the United States.

The Point of View of the Supervisor

Among the supervisors of recent engineering graduates who replied to the questionnaire addressed to them, are a number of men who are responsible for the introduction of college graduates into the telephone business and for the conduct of their preliminary training course. One of these men furnished us a controlled experiment, which serves as an admirable check on the results obtained from the others, by carefully analyzing the written reports of sixty-four such men and the talks of twenty-four who attend regular luncheon club meetings at which both formal and informal discussions are held. We have, therefore, obtained the opinions of about ninety carefully selected supervisors in the Bell System, who have something over 2700 such graduates in their organizations, and the results of the controlled experiment for a small group. In giving you the replies which were obtained from the supervisors' questionnaire, I shall speak of the results obtained from this special group separately.

The questionnaire sent to the supervisors was given the title, "The Effectiveness of English used by Engineering Graduates," and the following preliminary paragraph was included to amplify the terms used in the individual questions and to help in their interpretation:

> "Effective English, either written or spoken, must be correct, clear, and, when appropriate to its purpose, convincing. Correctness is a matter of grammar, spelling, and pronunciation. Clarity is gained by the use of words that are not ambiguous, sentences that are never unnecessarily long or complex, and paragraphs that express unity of thought. Conviction is obtained by range of vocabulary, aptness of illustration, vigor of style, and organization of thought."

The specific questions and answers to this questionnaire follow:

QUESTION 1: Of the engineering graduates in your organization who have finished college within the past five years, about what proportion (*A*) in their memoranda, letters, and written reports, use English that is (*a*) correct? (*b*) clear? (*c*) convincing? (*B*) in individual and group conferences speak (*a*) correctly? (*b*) clearly? (*c*) convincingly?

ANSWER: In the opinion of these supervisors, 75 per cent of the recent engineering graduates in this organization write English that is correct, 64 per cent use English that is clear and 50 per cent use English that is convincing. On the other hand, in their opinion, a somewhat smaller percentage in each case speak correctly, clearly and convincingly.

One or two comments concerning this question are significant. With regard to convincing written English, one man stated "With us conviction is a matter of reliability of data and validity of the deduction process, rather than method of expression. Organization of thought and range of vocabulary are conducive to clarity rather than to conviction. We are too close to the fundamentals of physics to be helped much by verbal salesmanship." Obviously our questionnaire was not phrased exactly enough to please everyone.

Another man writes, "I have read practically all of the reports prepared by our recruits after successive training courses. I have found grammatical errors, poor diction, ambiguity, limited vocabulary and failure to develop subjects logically, to a degree that I have felt disappointment in about 50 per cent of them and have been shocked in perhaps 5 per cent. I think, however, that they speak better than they write."

So far as written work was concerned the percentages of correct, clear, and convincing English found in the small control group corresponds almost exactly with those obtained from the whole set of questionnaires. In this special group, however, the percentage of men who spoke correctly, clearly, and convincingly was slightly less than 50 in each case —appreciably lower than seemed to be true for the larger number, but the standard of judgment may have been more exacting.

QUESTION 2: If possible, please state the specific defects, such as poor sentence structure, incorrect spelling, etc., which you have noted in the English used by these men and, if you wish, suggest ways in which these defects could have been overcome during their college days.

ANSWER: In the replies most frequent mention was made of poor sentence structure, limited vocabulary and poor organization of material. One man wrote, "The engineer seems to have an over-developed faculty for making any subject dry reading. He frequently substitutes long, weak phrases or perhaps sentences for well chosen adjectives." Another states, "The foundation of clear writing is clear thinking."

A third man writes, "Of specific defects in style, I should say that awkward and unwieldy sentence structure was probably the most prevalent and the most serious, as it always interferes with ease of reading, and often makes the meaning obscure. The following is an example, particularly weak because it is the first sentence of a paragraph, and should supply an easy transition from what has gone before: "In measuring these trunks, the end in view was not to record the balance obtained on each individual circuit but rather to gain an idea of the performance of a large group of tandem trunks of which these are typical examples." This sentence is not exactly ungrammatical, nor is it unintelligible if carefully read; but it requires at least two readings to be sure of the precise meaning. Many sentences contain too many ideas, or too many words, or both; while many others are obscure for lack of a few necessary words, or on account of awkward grammatical construction. The same is true of paragraphs, and of entire memoranda."

In the small control group the most frequent defects found were incorrect spelling, poor choice of words, excessive use of adjectives, loose wording of sentences, unnecessarily long sentences, and poor paragraphing.

QUESTION 3: If your experience permits comparison, do you believe that the English used by the recent graduates in Engineering is inferior to that used by (*A*) the recent graduate in Arts and Science? (*B*) the recent graduate in Business Administration? Please mention specific points at which you feel these graduates differ from those in Engineering in their use of English.

ANSWER: Of the supervisors' replies to this questionnaire, about two-thirds felt that the English of the recent graduates in arts and science was superior to that of recent graduates in engineering, and about half of these men felt that the recent graduates in business administration

were also better in this respect than the engineers. In general, greater ease of speaking and better choice of words characterize the graduates of curricula other than engineering. One man writes, "In general I believe that at least two-thirds of our young engineers do a good mechanical job in their written and spoken English. I do not think they have as wide a vocabulary or the variety of phrasing at their command as is usually possessed by the better arts graduates, but that on the other hand, engineers are much superior in their logical presentation of facts and arrangement of material."

The man who studied the small special group of graduates believes that the English of the recent graduate in arts and science is superior to the engineering graduate, but that there is no difference in this respect between the engineering graduate and the graduate in business administration. His statement is as follows. "Academic graduates in general seem to have an unlimited vocabulary and a ready fund of literary references which lend color and force to their English. They usually are better able to choose and apply words well adapted to the shading of thought and are inclined towards brevity and humor. Engineers usually are lacking in these qualities and tend strongly toward exactness, comprehensiveness and rigidity." My feeling is that this man has been most fortunate in his contacts with academic graduates.

QUESTION 4: Please give any general comments you may have concerning the training in English at engineering colleges and their graduates' use of English which have not been covered in the preceding questions.

ANSWER: The answers to this question represent so many different points of view that it is almost impossible to summarize them. A number of the supervisors feel that public speaking should be stressed, and an even larger number believe that students' college reports should be criticized very definitely for their mistakes in English. With these exceptions, however, the brief quotations which follow are much more significant than any attempt at summary.

One man, responsible for a wide range of personnel activities including supervision of employment and training of college men in one of our Companies, makes these comments, after alleging that he received poor preparation in English at an engineering college:

"I believe that most engineering colleges could very profitably give more consideration to the broad objective of developing greater ability in expression, both oral and written. I personally question the plan usually followed of adapting the conventional arts school English course to young engineers. There seems to be an aversion to the classical English course which is inherent in the engineering type of mind. Even the selection of textbooks and theme subjects, and assignments of collateral reading in literature are antagonistic to the technical man's interests and aptitudes. I believe that there is sufficient good literature in the form of biography or scientific and technical exposition to supplant many of the classics in the collateral reading assignments.

". . . There are advantages to be gained in making every engineering faculty man an English instructor. I would urge that a separate system of marks be given in courses other than the English course itself, for ability in expression, both oral and written. In other words, make every written laboratory report also a theme in English for grading; similarly, make every recitation a drill in public speaking or conference technique. Moreover, a little letter writing practice might be beneficial.

I suggest such exercise as the preparation of letters of transmittal for each laboratory report, with alibis for their lateness more carefully and formally phrased.

. . . . . .

"I might also add that an active interest in student branches of the technical societies or in literary societies should be encouraged to the extent of their carrying some credit toward the requirements for a degree."

A supervising engineer in a research and development organization puts it thus:

"It is my feeling that in general our educational system falls down throughout its course in the lack of attention which is given to instruction in the *use* of English as a tool for expression. I am inclined to go so far as to suggest that in view of the limited time available in preparatory school and college work, the compulsory study of foreign languages should be materially curtailed in order to permit more time to be given to English expression and to the study of such background subjects as logic and psychology and to the critical analysis of the methods and manner of expression used by recognized experts. It has been my experience that in the study of English literature too little attention has been given to such analysis. This is probably natural because it requires more skill and effort on the part of the instructor."

One of his associates writes as follows:

"What I do find lacking in the case of more than half of the younger engineers is ability to explain a proposition either verbally or in writing in such a way that an individual or a group can acquire an understanding of the essentials in reasonable time and without considerable cross examination. The fault is usually failure to appreciate what is already known about the subject at hand and just what has been contributed by the young engineer in the way of important new information.

"Another trouble is failure to appreciate that (particularly in a large organization) it is sometimes necessary to do a lot of work simply to boil down knowledge. A 40-page report may be in excellent literary style, but very bad from an engineering point of view if for the purpose at hand the essential information could have been given in, say, one page."

Another man responsible for college employment and training has this to say:

"The great difficulty seems to be that interest in good English is pretty much restricted to the teachers of that subject. The teachers of other subjects in the schools and colleges do not adhere to its use as consistently as one might expect and do not make a sufficient effort to impress upon their students the importance of such usage.

". . . It seems to me that the establishment of an English course in an engineering school cannot be a solution of the problem unless very direct coöperation of the professors of other subjects can be enlisted to constantly impress upon the minds of students through example and suggestion the importance of this very essential part of their education and development."

A specific suggestion comes from this engineer who writes:

> "It would probably help if the students in the colleges were given more training in writing material which consisted in explaining or reporting on something to an audience which had little detailed knowledge of the subject matter."

Finally, these pungent remarks came from a scientist who has done much writing and speaking himself:

> "I know of only one way in which defects in English may be corrected and that is to wish to correct them. Conviction of sin and desire to reform are essential. Given that attitude of mind, it remains only to select one or two defects and to concentrate upon them until the proper habit has been established. When that is finished, another selection may be made. If more than two or, at the most, three solecisms are selected, the effort to reform is too diffuse and usually futile."

The Point of View of Deans in Graduate Schools

It proved rather difficult to find many deans of graduate schools who have a great deal of contact with engineering graduates as well as those from other types of college curricula. Two such schools are Law Schools which specialise in the patent field. The Dean of one of them has written that he has never had any occasion to make differentiation between the quality of the English used by engineering students and that of students from other college courses. The Dean of the other makes the following statement:

> "Our experience with such men in their written examinations and in oral work in the class room shows that in their use of English, both in speaking and in writing, they are more accurate than most students. This is particularly noticeable in their written examinations.
>
> "We do find, however, that some engineering school graduates are handicapped to some extent by lack of experience in public speaking. The hearing of patent cases does not form a very large part of the work of a good many Federal judges. Naturally, they rely, to a large extent, upon the oral as distinct from the written argument when hearing such cases. It is, therefore, a distinct advantage for the patent attorney to have not only a command of accurate and precise English, but also the fluency which can only come from experience in addition to a sound training in public speaking."

The other type of school likely to have graduates from several college curricula is that of Business Administration. The Dean of one such school gives his opinion in the following way:

> ". . . judging from the products that come to us at the Graduate School of Business . . ., I am inclined to think that such teaching leaves a good deal to be desired. Unfortunately the same is true in respect to graduates of colleges of Arts and Science. The fact is that engineering colleges which are parts of universities, usually have the same instructors in English that the other colleges have, and, at the present, I think they are requiring just about as much work as is required in other colleges.

As between students in different departments, it becomes largely a matter of secondary school training, aptitude and taste to determine how individual students make out with English.

"The present tendency, I think, is clearly to require more work in English. Additional requirements probably carry with them somewhat better performance, but I am inclined to think that the emphasis is too much on requirements expressed in terms of units, and too little on specific performance. Off hand, I should say that . . . from twenty to thirty per cent of the students have considerable difficulty in handling the writing of reports required in the Graduate School, and this means that the ability of these students to write English is much less than it should be."

Probably the most specific comments have come, through the Dean, from the professor in charge of the work in English at another such school, where I happen to know that many men with engineering degrees receive postgraduate training in business. His remarks follow:

"The difficulties of engineering students in writing reports in the Business School are similar to those of college graduates. One difficulty is that the engineering student finds it hard to handle well a problem which cannot be proved mathematically. He lacks ability to present his arguments effectively. This difficulty is reflected in the lack of organization of material, as well as lack of knowledge of grammar and correct English usage.

"The organization of reports is likely to be weak in several respects. Usually the approach or introduction is beside the point or not forceful enough to get the reader's interest. Not infrequently, one or two pages are wasted on extraneous material. Further, transitions from one idea to another often are not clear. In other words, since the relation of one part of the report to another is not apparent either in the introduction or in transitional sentences or paragraphs, it is incoherent. Finally, the organization of paragraphs is ineffective. Oftentimes they are too long, so long that they lose the emphasis which is desired. There is also lack of unity in the paragraphs. Paragraphing is such an important part of an effective presentation that it can not be overemphasized.

"That knowledge of grammar or its proper applications is inadequate, is particularly noticeable in the matter of sentence structure. Verbs still fail to agree with the subjects, and sentences are incomplete; statements and statements of a series of facts or ideas are written incorrectly. Long, loose sentences still persist. Furthermore, punctuation of sentences is not wholly satisfactory, especially with respect to the use of commas and semicolons. Spelling is frequently poor, if not bad. Whether this is the result of real inability to spell or whether it is carelessness represented by lack of editing reports, I do not know.

"Knowledge by students of correct usage of words seems to be restricted. The traditional errors in the use of 'affect' and 'effect,' 'principal' and 'principle,' and 'due to' are common. Vocabularies generally are limited, with the result that some words are overworked. Thus the force of a good word is frequently lost.

"I feel that students generally do not have as much pride in their reports as they should. Editing for errors in spelling and typing is an essential of good workmanship. Ordinarily when the effects of slight

errors on a reader are called to the attention of the student, he appreciates their importance."

Summary

To sum up the points of view of these three groups of men, it is evident that a substantial part of the engineer's time is spent in work requiring written or oral expression and that a large majority of the younger engineers believe more emphasis should have been placed on English during their college days. In the case of a substantial minority, work involving writing or speaking was more difficult for them than their other work and, in a similar proportion of the cases, the results were not satisfactory to their supervisors. Half of the graduates and two-thirds of the supervisors believe that Arts and Science graduates, and to a somewhat smaller degree, graduates in Business Administration excel engineers in the use of English.

The most frequent suggestions for improvement are (1) a greater emphasis on the value of English that its importance may be recognized by the undergraduate. (2) Scrutiny of engineering and other reports for errors of expression and lack of clarity. (3) Additional English courses, especially in Public Speaking.

These results, on the whole, hardly warrant despair on the part of the teachers of English in engineering colleges. When the difficulty of their task is appreciated it seems they have done astonishingly well with it. There are, at least, two unique inherent difficulties which they face. In the first place, the engineering student is the sort of man who expresses himself far more naturally in concrete and mathematical symbols than in words. In the second, his courses other than English give him very little opportunity to write or speak as compared with the students in other curricula who write in all and speak in many of them. These distinctions amply explain the differences in their facility.

But something substantial remains to be done. One thing obviously is a somewhat different attitude toward English in the whole engineering faculty and effective reflection of that attitude in the student body. I feel that the data presented here fully justify you in urging this most vigorously. Beyond that, if I were president or dean of an engineering college, I should feel warranted in asking why the following requirements in English were not the minimum necessary in its curriculum, fully realizing that excellent reasons might be given to the contrary.

(1) A freshman course definitely pointed to correct, clear writing and speaking, through frequent compositions, class discussions, and a certain amount of reading, with an inflexible standard of performance.

(2) The reading outside of class during sophomore and junior years, of ten to twelve great books, with written or oral examinations to make certain that they had been more than superficially covered.

(3) A substantial seminar course in senior year, where written and oral reports of some length and complexity are presented and discussed for organization of thought, choice of language, and style.

In addition, I should urgently request every member of the faculty to scrutinize papers in all courses, from time to time, especially where the nature of the material makes it appropriate, from the point of view of correct and clear English. It is probably true that such a procedure would not be practical in the case of all student reports.

These suggestions require an adequate staff, a problem which, as I am not president, or dean of an engineering college, I shall leave to those who are, but urgently commend to their attention.

THE ART OF TECHNICAL WRITING*

By GEORGE A. STETSON,
Editor, The American Society of Mechanical Engineers

It would be presumptuous of me to treat this subject, "The Art of Technical Writing," by elaborating upon the details of literary craftsmanship as applied to papers for scientific and engineering audiences. Several excellent textbooks are devoted to these details and all of you are familiar with them. I propose, therefore, to emphasize two important aspects of this general subject, appropriateness and brevity, and to touch upon the publication problem of a professional society as it is affected by those who write the papers presented to it, and the work of the American Standards Association on Symbols and Abbreviations for Scientific and Engineering Terms.

Brevity Saves Readers' Time and Publication Expense

Editors are ruthless folk. If they are not born with an element of ruthlessness in their natures they soon acquire it in the practice of their vocation. Shears, paste pot, and the blue pencil are the symbols of their craft. Exercising their prerogative of expressing themselves as they see fit in their own editorials and special columns, they change, cut, and delete the literary products of others with what their contributors must frequently believe to be a truly fiendish glee. Many an author, in viewing his shorn brain child in galley proof, has sworn never again to put pencil to paper and has announced to the editor in no uncertain terms this resolution of self restraint. I recall, for example, one irate and ironic author who complimented me upon having compressed his half hour's speech into seven lines. But such incidents are all in the day's work of saving the reader's time, patience, and money and turning over to him something that will be worth while; for the editor is the screen that holds back all but the best of the material that flows through his establishment.

Every time I read that excellent little monthly known as the "Reader's Digest," I wonder what more I would have learned if I had spent ten or twenty times the effort with the original articles.

* Presented at the Session on English of the Society's Summer School for Engineering Teachers, The Ohio State University, July 25, 1932.

Each condensation seems well and logically put together. It begins, ends, and expresses its ideas and it is not tiresome. What admirable economy. Why is more of it not practiced?

The answer lies, I believe, in the fact that this kind of writing is the hardest to master. Almost anyone can go voyaging on an ocean of words and bring up at some distant port if time means nothing to him, but it takes a skillful navigator to stick to the best and shortest route, with the ultimate destination as the only port of call. Trying to express too many ideas in one paper and using words and sentences with prodigal wastefulness are the common faults of inexperienced writers.

Is it necessary for me to violate this cardinal principle of brevity by detailing its rather obvious advantages? How many books, magazines, and papers do you read? How much reading must you do to keep up with your specialty and with contemporary events? Do you lay aside the six- or twelve-page article to be read when you will have more time (which seldom is ever found) and content yourself with the briefer ones that neatly fill a page, a column, or a paragraph? Others read the same way and will thank you for holding them by the buttonhole for the briefest tale you can tell. As a writer you have always to compete with another interest, and you may not be as successful as the ancient mariner in detaining the wedding guest, for your story may not be as absorbing.

Write With the Reader in Mind

Let us return to the "Reader's Digest." You may say that this little magazine is not concerned with "technical literature" and that I am supposed to be talking about the art of technical writing. I admit this difference, but the ideal is there. Recently I bargained with an engineer for four pages and got six. Without removing important material I could not for the life of me put it into less than six pages. The slender rivulet of text that meandered through a meadow of footnotes, cuts, and tables, if I may paraphrase Sheridan, was so meagre that scissors provided the only means of subdividing it. The article in question gave data for designers and references to source material. The author was providing working tools and not general information. He was making no attempt to describe something new, to convince by arguments, or to entertain. He knew that his readers would say, "Good, I'll need that some day," and would straightway cut it out and file it. As general reading it had no function, but it served its specific purpose admirably.

This then is a second objective of technical writing, to have a purpose and to stick to it; to make the paper appropriate to the

occasion. The writer of a technical paper should ask himself, "Why am I writing this? What do I wish to accomplish?" and his honest answers to these questions will determine what he wants to say. The editors of the "Reader's Digest" ask themselves these questions and the answers to them reflect the aim and policy of their magazine. They want to present a broad landscape by means of a series of unrelated snap shots instead of a complete panorama. The subject matter of their condensations served another purpose in its original form of publication and was undoubtedly appropriate to the conditions of that first publication. It could be reworked and rewritten to serve many other purposes, and thus be made appropriate for other audiences and other occasions. The purpose would in every case determine the character of the article and the method of handling the material. Let us examine how this applies in technical writing.

Many Papers May Result from the Same Subject Matter

Suppose, for example, an engineer has made an analytical study of a research problem. What literary possibilities may come out of this study? Obviously the record of what has been done should be written down. From this a report results into which is generally dumped every scrap of pertinent data, every mathematical derivation, every curve sheet, descriptions of equipment, method, theory, results, and conclusions in a tiresome hodge-podge of words and illustrative material whose chief and perhaps only virtue is completeness. But as this is a record, some importance may be attached at some time to every detail and hence every bit is preserved.

But now the engineering investigator is seized with an urge to publish. Perhaps a dean is scanning bibliographies for evidences of productive scholarship on which to base promotions. Perhaps a harassed program committee is looking for a speaker, or an editor hears of the work and wants an article. What shall the engineer do?

Obviously this is one of those cases where a subject is already at hand and an abundance of material exists. The actual mechanics of producing the engineering paper alone remains. The aspiring author is therefore faced with a problem the importance of which is appreciated by none but the seasoned writer. He must decide upon a method of presentation that will suit his audience. He must consider the nature of this audience carefully and he must realize not only the limitations of its background, its knowledge of the subject to be discussed, and the extent of its interest in that subject, but he must also realize the limitations of his ability to tell his story to this audience. Let me illustrate.

We shall suppose that the engineer author is to prepare a paper for presentation before a professional society and that a paper for inclusion in permanent form in the society's transactions is expected. What possibilities confront him?

First of all there is his contribution to the permanent literature of his profession. A technical paper must be prepared. Upon it depends the author's reputation as an engineer. The paper must be accurate, clear, concise, and, at the same time, complete. It must be logically thought out and skillfully put together, with substantiating data and descriptions of apparatus and technique that will inspire confidence. The conclusions must be clearly and definitely stated, with whatever qualifications seem necessary. Others will check the data, appraise the technique, and form their own conclusions. Some may wish to use the results and data presented in the paper in important works of their own. The author should have these men in mind and present his material so that it will be of maximum benefit to such practioners. The cuts, curves, tables, and mathematics must be carefully studied and planned. Here details will be necessary, there they may obscure the main theme. How will the reader interpret the conclusions? His time and effort must be saved. It is right to expect that the reader must apply some thought and study to the paper because it is not diversion he is seeking but help in his own problems. He will not read it as he reads a story. He will study it at his convenience—spend days on it, perhaps. Even so his time and effort must be saved, and perhaps some of the details that substantiate and amplify the main thesis can be put into appendices, leaving the main article a straightforward development of the essential features, beginning with an explanation of purpose and scope, and ending with a summarized statement of results and conclusions. Five pages or fifty? The extent and importance of the subject matter, not the time available to the reader, will determine the length.

Another possibility exists in the way of a less extensive and a not so highly technical paper presenting these same results to a group of engineers who are not specialists in this subject but whose interests are related to it. Obviously considerable detail must be avoided. Emphasis must be on the results and their significance and adaptability. The paper must tie in to the general interests of these readers. Much of the substantiating evidence and description of apparatus and technique can be omitted as readers will be chiefly interested in results and their significance.

An oral presentation of either of these types of papers would be an expected corollary in any event. Now must the writer beware. His time is limited. His audience cannot study the details

of his apparatus, his technique, his tabulated results, his beautiful curves and sketches. He must present his story in abbreviated form, appealing to his audience largely through their ears. If he uses lantern slides, they must be simple, with but few lines and little reading matter. His sketches must be truly sketches; otherwise their significance will not be grasped because the detail cannot be studied. If he uses mathematics it must be very simple and easily followed, the long derivations being omitted and only the significant equations presented. This presentation abstract, to be effective, must be worked out as carefully as the original paper. Under but few circumstances can the complete original be read profitably to an audience.

But the experts who will study the details of a complete report, the engineers who have related interests in certain phases of it, and the audience that may hear its oral presentation are not the only persons to whom the author may wish to address himself. A more general audience in the form of the readers of technical periodicals offers an opportunity for a broader publication of the research. For this audience the author must confine himself to a limited number of words, tables, and illustrations, avoid as much detail and mathematics as possible, make a conscious effort to capture interest, and make clear his conclusions. It is a painstaking task.

In addition to these engineering audiences others exist. It is perfectly clear that if this author wishes to reach non-engineering audiences, he must rework his material and write with them especially in view. The newspaper and the general magazine, the radio broadcast, all offer legitimate opportunities to the author to spread abroad through the world the significance of his work. This is, perhaps, one of the most neglected fields of technical writing.

Society Publication Problems

Enough has been said—and all of what has been said is obvious—to emphasize the two main points I wish to bring out, *i.e.*, that the technical paper should be appropriate in treatment to the occasion and manner of its presentation and publication, and that it should be as brief as possible for the sake of economy of time and publication expense.

Let us now look at the problem of technical writing from the point of view of the professional engineering society. Such groups are organized for the expressed purpose of building up the literature of the technologies that lie within the scope of their interests. Not only must they provide outlets for the literary efforts of their members but they must actively stimulate the writing of many

papers in order to get on record practices and researches that are of value to the profession they represent. They are vitally interested in these two factors that I have emphasized.

The task of a publications committee in an engineering society is one that involves selecting the best material for printing and keeping its costs within reasonable limits. With one eye on the society membership, the committee strives to provide as much material of high quality as possible. It is inclined to listen sympathetically, even in the face of its own counter opinion, to the recommendations of the agencies of the society which procure the papers for presentation at meetings and those of other agencies sponsoring research projects. Its other eye, however, is on its budget. Publication costs a surprising amount of money. Line for line it costs as much to print rot as it does to print wisdom. Brevity is a virtue greatly admired by publications committees. All such committees would, I feel quite sure, join with me in urging you, as teachers of English to engineers, to strive for clear and concise writing by your students. The technical press would also, I know, second this request. And the reader, who gets the benefit of the reduced printing costs and less wasting of his time, will offer a vote of thanks to you and to those whom you convince to practice brevity.

Standard Symbols and Abbreviations

I come now to my final point. The American Society of Mechanical Engineers, in common with other societies and publishing bodies, has had its own style manual covering conventional procedure in the preparation of manuscript for printing. It is hoped that a revised and more complete manual can be issued as soon as conditions permit. Since the present manual was prepared, however, a series of standard symbols and abbreviations of scientific and engineering terms have been issued, in final or tentative form, by the American Standards Association. It is to be hoped that all teachers of English to engineers will acquaint their students with these standards and make use of them to as great an extent as possible so that the coming generations of engineers will be more consistent and less individualistic than their predecessors have been. It is only by getting these standard symbols in use by authors of papers that substantial progress toward a quicker comprehension on the part of a reader of the significance of a given symbol can be achieved. Chemists have long since adopted conventional symbols for the elements. They are familiar to all educated persons. But equally useful concepts in other branches of science and engineering are represented by no such uniformly used symbols. Why must some writers use L for latent heat and others r? What con-

ventional signs in mathematics are approved and what are not? Do H, and b, and v always mean the same thing in papers on hydraulics? How much easier it will be for all of us when a standard practice in the use of these necessary symbols becomes part of the consciousness of every engineering student. It saves hours of reader time to use A for area rather than some other symbol that is unfamiliar. Those of you whose duty it is to direct the students' attention to the details of technical writing can help in this standardization movement by letting him know that these standards exist.

A Summary of What to Do

My formula for writing a technical paper is, therefore, summarized as follows:

1. Become thoroughly familiar with the subject and assemble all the material at your disposal. Don't neglect the literature.

2. Decide upon the purpose and scope of the paper as affected by the occasion and the audience. Visualize the persons to be addressed, their familiarity with the subject matter, their education, interests, prejudices, etc. Determine the limitations of time, space, illustrative material, etc., and get from those who ask you to prepare the paper or who intend to publish it any special instructions that may be helpful to you.

3. List the major items to be covered and choose the material to be used.

4. Get a good title, not too long, not too general, but precise and significant.

5. Let the reader know at once what you propose to write about and of any major conclusions that can be effectively divulged.

6. Get his interest at the start and keep it.

7. Have him constantly in mind while you write and don't "write down" to him.

8. Choose some logical order of presentation and stick to it, building on the reader's knowledge and interest.

9. Be careful in the choice of words and in the use of examples and analogies. Avoid pedantry and unusual terminology; explain unfamiliar words if they must be used. Use standard symbols and abbreviations.

10. Be brief, but clear and coherent. Save the reader's time and publication expense.

11. Leave out irrelevant details and qualifying phrases that are obviously unessential. Let curves, sketches, illustrations, and tables tell as many of the tiresome details as possible. Don't interrupt a well-planned story with substantiating material and mathematical demonstrations that can be relegated to appendices

for the use of those particularly interested in them. Don't quote at length when you can refer to the original.

12. Give the reader a good bibliography but don't annoy him with too many footnotes. Provide a good summary and a brief synopsis.

13. When the paper is written, check it over to see if it is properly proportioned. Pay particular attention to first and concluding paragraphs. Check all references, figures, computations, mathematics, numerals, drawings, and other details.

14. Lay the paper aside and read it over several days later to make sure it is complete, well-proportioned, logical, and coherent.

15. Be properly humble about your paternity. Welcome rather than resent suggestions for improving your paper and give the editor as much credit for knowing his job as you would like to have him give you for knowing yours.

NEW MEMBERS

ALLEN, LOUIS N., JR., Instructor in Civil Engineering, Stevens Institute of Technology, Hoboken, N. J. F. DeR. Furman, W. R. Halliday.

BLODGETT, HOWARD B., Assistant Professor of Civil Engineering, South Dakota State College, Brookings, S. D. H. S. Carter, H. M. Crothers.

BRAHTZ, JOHN H. A., Research Fellow, California Institute of Tecanology, Pasadena, Calif. Franklin O. Rose, Carl Thomas.

DIXON, TOD G., Instructor in Chemical Engineering, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, Allen Rogers.

HORNER, HARLAN H., Assistant Commissioner of Higher Education, New York State Education Department, Albany, N. Y. F. L. Bishop, Nell McKenry.

JONES, WEBSTER N., Director, College of Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. Thos. S. Baker, F. L. Bishop.

KOFFOLT, JOSEPH H., Assistant Professor of Chemical Engineering, Ohio State University, Columbus, Ohio. James R. Withrow, E. A. Hitchcock.

RICH, KENNETH W., Supervisor of Mechanic Arts, Kern County Junior College, Bakersfield, Calif. Wm. M. Holmes, R. W. Sorensen.

STEFANI, LUIS, Professor of Mechanical Engineering, University of Porto Rico, Mayaguez, P. R. C. C. Mota, F. L. Bishop.

VETTER, HARRY F., Instructor in Electrical Engineering, Stevens Institute of Technology, Hoboken, N. J. Frank C. Stockwell, F. DeR. Furman.

WEIMAR, GEO. MARTIN, Associate Professor of English and History, Stevens Institute of Technology, Hoboken, N. J. F. DeR. Furman, W. R. Halliday.

ZSCHOKKE, ARTHUR J., Teacher of Engineering, Ventura Junior College, Ventura, Calif. H. B. Langille, Franklin O. Rose.

96 new members this year.

COLLEGE NOTES

Armour Institute of Technology is particularly pleased to report that Doctor Willard E. Hotchkiss has been elected President and has assumed office. Since the illness of Doctor Howard M. Raymond, last spring, and his retirement from active duty with the rank of president emeritus, executive responsibility at the Institute has been in the hands of a committee of the faculty.

Doctor Hotchkiss is a graduate of Cornell University, where he received degrees of Ph.B., A.M., and Ph.D. Northwestern University has conferred on him its degree of LL.D.

His teaching experience began at the Wharton School of Finance and Commerce at the University of Pennsylvania, where he was acting professor of Industry. From 1905 to 1917 he was on the faculty of the School of Commerce at Northwestern University, and for the latter nine years of this period was dean of the school. During the following two years he was at the University of Minnesota as a member of the faculty of the department of economics and as director of business education. From 1920 to 1925 his college work was interrupted by his responsibilities as executive director of the National Federation of Clothing Manufacturers. He returned to educational work in 1925, and until 1932 was dean of the Graduate School of Business at Leland Stanford Jr. University. During the current year he has been on leave of absence from Stanford and has been a special lecturer in the School of Commerce at New York University.

To a conspicuous degree, Doctor Hotchkiss has been engaged in service to industry and to the community, while on university faculties and at other times when such service required all his attention. He was associated with Dean Joseph H. Willits of the Wharton School in industrial research connected with reorganization in the upholstery industry in Philadelphia. In 1910 he was director of the federal census in Cook County, Illinois. While at Northwestern University he was chairman of a citizens' committee investigating juvenile courts in Cook County. In the winter of 1917–1918 he was delegated by the secretary of war to study labor conditions in the logging camps of the northwest. In 1918 and 1919 he was secretary of the Shipbuilding Labor Adjustment Board. In 1920 he was executive secretary of the Industrial Conference appointed by President Woodrow Wilson, containing in its membership Mr. Herbert Hoover, Mr. Owen D. Young, and Mr. Stanley King. As noted above, for five years he was in active charge of

industrial relations in the clothing industry. While at Stanford he was chairman of the California Economic Research Commission.

Doctor Hotchkiss has been vice-president and member of the board of editors of the American Economics Association; he is a director of the Taylor Society; he was one of the organizers of the Society of Industrial Engineers.

For many months the trustees of Armour Institute of Technology have searched for a president. The success of the search is gratifying. Doctor Hotchkiss' record of important duties well done; his broad experience in education, in industrial and social problems and in administration; and the hearty commendation of those with whom he has worked, are evidence that the affairs of the Institute will be in capable hands. His associates on the faculty are confident that after forty years of successful operation the school can look forward, under Doctor Hotchkiss' administration, to continued success and to increasing service to industry and to the community.

The **Case School of Applied Science** will be host for a conference on *Re-Engineering for Economical Manufacture* to be held on March 22, 23, and 24.

This conference will be the eighth sponsored jointly by the Case School of Applied Science and by The Cleveland Engineering Society, together with representatives of the National Engineering Societies. Professor E. S. Ault, Associate Professor of Mechanical Engineering, is general chairman of this conference.

Officials of manufacturing industries and such authorities as Mr. John M. Carmody, Editor of *Factory and Industrial Management*, will be the speakers, after which the open forum principle will be maintained.

Wednesday Evening, March 22, 1933:

1. *Planning for Profits.* John M. Carmody, Editor of *Fact. and Ind. Man.*

   A joint meeting with the C. E. S. and A. S. M. E. A discussion of the way engineers are facing new problems in management, production, maintenance, engineering and sales; the necessity for long range planning.

Thursday Morning, March 23, 1933:

2. *Production Development—Whither Bound?*

   Summary of past development, present uncertainty, tendency for the future in view of such movements as "technocracy".

3. *The Economic Aspect of Entering Competition in Another Industry.*

The relative advantage to company, industry and society of extending manufacturing activity to an additional product in a field in which competition is already keen.

4. *Redesign of the Product to Increase Appeal to the Purchaser.* The influence of finish, appearance, flexibility, ease of operation, and return of investment.

Thursday Afternoon, March 23, 1933:

5. *Economical Selection of Equipment.* Choice of proper kind and type of equipment. The factors influencing the purchase of equipment in times of full and reduced production.
6. *Developments in Improved Manufacturing Processes.* Reduction of production costs by using suitable materials and improved production processes.

Friday Morning, March 24, 1933:

7. *Metal Forming to Eliminate Machining.* Special forging and coining.
8. *The Place for Stampings in the Product.* When stampings may be used with profit. How the use of stampings affects other parts of product.
9. *Influence of Welding on Design and Production.* Application of welding to promote simplicity and to reduce time and cost of production.

Friday Afternoon, March 24, 1933:

10. *Changes in Plant Layout to Accommodate Varying Production.* Rearrangement of portions of equipment for most effective operation and control of production of varying volume and small quantities.
11. *Selection of Economic Manufacturing Quantities for the Small Industry.* Build-up of basic principles and illustration of the application to specific cases.
12. *General Factors Entering a Production Program.* A brief review of the many factors that have not been treated in the conference and guidance as to the sources of information available.

Colorado School of Mines.—Enrollment for the school year 1932–33, while a little below that of the record year previous, was not affected by the depression as much in proportion as other state schools and other technical institutions throughout the country. The trend this year has been for a larger number of Colorado students and fewer men from out of the state.

A smaller income with which to run the School has led the administration to adopt measures of the utmost economy. Faculty

salaries were cut early in 1932, and it has been the policy of the faculty to carry on its work with the usual efficiency in spite of economic conditions.

The School of Mines geological field laboratory at Wild Horse Park, probably the only one of its kind in the country, is still in the process of development. All new work was curtailed at the Park, but enough has been done in the past few years to make the area a fine training ground for geologists.

Early in 1931 the metallurgy department changed the furnaces in the assay laboratory from coal to natural gas burners. This change was made for purposes of economy and convenience, and it has worked out splendidly. The introduction of Carbo-Frax muffles was found to be successful, and the cost of natural gas firing is no greater than of coal firing, in spite of the fact that the gas comes from Amarillo, Texas, more than 500 miles from Golden.

The department of geophysics has done considerable work during the fall for the state in oil and placer mining development. Placer mining, in particular, has been flourishing in Colorado since hard times have thrown so many men out of work, and the Mines geophysicists have aided to a great extent in the work.

In the geology department, the petrographic division has advanced notably in the past few months. The examination of sedimentary rocks by microscopic methods has played an important rôle in oil field development. Curtailment of drilling operations by many oil companies has made it necessary for these companies to discontinue the study of well samples. The School of Mines has been particularly fortunate in securing these well samples through the work of Professor W. A. Waldschmidt, of the geology department. Nearly 100,000 well samples from producing fields, wildcat wells, shallow core drill holes, outcrop samples, and samples from measured sections have been secured.

These samples have been carefully catalogued and filed, and they make up what is probably the best reference collection of well samples in the United States. They will be of great value for reference in future geological work in exploration for oil, or for work in stratigraphy.

During 1933 the Colorado School of Mines will continue its policy of strict economoy, and every attempt will be made to keep the standards of the School as high as they have always been.

Columbia University.—At its annual meeting in Boston the week of September 26, 1932, Dean J. W. Barker was elected President of the Illuminating Engineering Society.

An Engineering Senate has been organized at Columbia for each of the Departments of Civil, Mechanical, Electrical, Mining,

Industrial and Chemical Engineering. Each Senate is composed of four alumni and four non-alumni who are active leaders in their respective fields of engineering. They are men who have not only made considerable progress in their profession but have not forgotten the technical aspects of engineering education. They are of different ages so that the various eras will be represented. Dean Joseph W. Barker of the Columbia Engineering Schools serves on all the Senates and directs and coördinates their efforts. The Columbia Engineering Alumni Association nominates one half of the members and the various national engineering societies the other.

The Senates were formed to bring the educational side of engineering in contact with the practical phase of the profession and to prevent the theoretical from becoming antiquated in the light of modern methods. Engineering educational societies long have felt the need of an organization or system by which the theoretical phase of engineering could be brought into closer contact with experienced engineers.

In order to acquaint the Senate members with the aims of the Columbia Engineering Schools the first meetings have been devoted to orientation, aims, methods of instruction, and facilities of the several departments. In time the meetings will probably go into the details of curriculum in regard to its relation with the actual practice of engineering.

The term of office of each Senate member is four years with two new members appointed each year.

Massachusetts Institute of Technology.—A substantial grant from the Rockefeller Foundation has made possible an expansion of the high altitude weather research which the Department of Aeronautics has been carrying out since November, 1931. Three miles above Boston observations are taken every day when flying is at all possible.

Dr. K. O. Lange, who joined the Institute staff in October, 1931, has already had five years of aeronautical meteorological research at Darmstadt, Germany, before undertaking this problem in collaboration with Professor Daniel C. Sayre who has made most of the flights.

It is hoped by means of these daily observations that it will be possible to determine the characteristics of North American air masses over Boston and thus ultimately to extend the application of air masses to weather forecasting.

About 90 per cent of the scheduled flights have been completed and encouraging results obtained.

Michigan College of Mining and Technology.—Beginning this June, Michigan Tech undergraduates may, if they prefer, work

toward a general Bachelor of Science degree instead of toward one of the specialized B.S. degrees now conferred in seven branches of engineering and in geology and chemistry. This addition was voted by the college faculty in December and approved by the board of control a month later.

Hours necessary for graduation will be the same as for present degrees, but required subjects will be considerably fewer. They include three courses in mathematics, three in physics, four in chemistry, one in metallurgy, three in economics, one in mechanical drawing, one in electricity, one in mineralogy, three in geology, and also American government and politics, essentials of English composition, technical writing, public speaking, and business letters. Subject to the approval of the registrar, electives may be taken in any of the scientific, engineering, or humanities departments.

A general Master of Science degree will also be added to the present specialized ones. As a result graduate students may henceforth write theses in mathematics and physics, including geophysics, as well as in engineering, geology, and chemistry.

At its January meeting the board of control likewise appproved the addition of fifteen courses in the departments of mathematics, chemistry, and civil, electrical, mechanical, military, and mining engineering. Among them are mathematics of finance, bridge design, electric railways and railway electrification, alternating current circuits (advanced), transients (advanced), valve gears, river and harbor improvements, coal preparation, and mine-inspection trip II, to be taken outside the Lake Superior copper and iron regions and to alternate with the present trip within those districts.

For next year Michigan Tech has been officially designated as one of the colleges to which a West Point graduate will be sent for advanced training. From a dozen to fifteen officers are given such training annually. The man to enroll at Houghton will specialize in river and harbor study and in hydraulics, according to word received by President W. O. Hotchkiss.

Stevens Institute of Technology announced recently to students graduating from high school or preparatory school in midwinter 1933 that a special section of Freshmen will be admitted to the college at the beginning of the second term of the college year, February 1, 1933. The curriculum designed for this special section of Freshmen will permit members of it to complete the full college course with the Class of 1936 and to graduate with that class in June, 1936. Members of this section of the Class of 1936 will attend two summer sessions, one at the Engineering Camp in 1933 and one on the campus at Castle Point in 1934. A similar group will be admitted to college in February, 1934.

Stevens Institute of Technology has previously admitted students only in September. This departure from customary procedure is prompted by the fact that many young men graduating from preparatory schools in midwinter 1933 are faced by peculiarly difficult conditions under which it is not likely that they can find temporary employment while waiting for admission to college. Admitted to college in February, they avoid a half-year's delay and by summer work they may overtake the class which entered in September, thus saving a full year in the time of their graduation. Prospective students are advised not to try for midwinter admission unless they have confidence both in their scholarship and in their physical vigor.

The terms of admission are similar to those governing entrance to college in September and tuition and fees will be payable at the same times and in the same amounts as are paid by the other members of the class with which they will graduate.

During the past two summers, 1931 and 1932, Economics Conferences for engineering graduates have been held at the Engineering Camp of Stevens Institute of Technology. Alumni associations of nine engineering colleges were associated in the invitation which was issued for last summer's session. These Conferences have been each of a little more than a week's duration. The general theme of last summer's Conference was "Money and Banking."

At the suggestion of several members of the summer conference, Stevens Institute of Technology is now holding a series of fortnightly Economics Forums. The first five meetings have been for the consideration of the following topics: "Economic Problems of the Next Congress," presented by Professor W. D. Ennis; "Tariff," a debate by eight members of the group; "Intergovernmental Debts," Rufus S. Tucker, lecturer; "Unemployment Insurance," William Maxwell Barclay; "Currency and Fiat Money," Professor Walter E. Spahr, New York University; "Currency: Good Money and Bad," by Professor Frank W. Fetter of Princeton University. Attendance at these fortnightly meetings has ranged from forty to eighty-five.

SECTIONS AND BRANCHES

The 1932 annual meeting of the **Middle Atlantic Section** of the Society for the Promotion of Engineering Education was held at the Newark College of Engineering, Newark, New Jersey, on Saturday, December 3, 1932. A large number of delegates and guests were in attendance, the total present at luncheon being one hundred and forty-four.

Following registration, many of the delegates were taken by bus to visit

(1) The Newark Airport, which is the busiest airport in the world, clearing more passengers, planes, and mail than Croyden, Le Bourget, and Tempelhof combined.

(2) Kearny Station of the Public Service Electric & Gas Company, where they inspected the installation of the mercury-vapor generating unit. The second in the United States of a plant of this type.

A delightful complimentary luncheon was served at 1:30 in the Academic Building of the College, and in room 30, adjoining, the Section went into session at 2:45 P.M.

Dean James A. Bradley, of the Newark College of Engineering, welcomed the Section, and turned the meeting over to Chairman Robert C. Disque. The minutes of the spring meeting at Swarthmore were read and approved, and the treasurer's report was read and adopted. The chairman then appointed committees on (*a*) Resolutions, (*b*) Nominations, and (*c*) Meetings.

The following papers were presented:

(1) "Some Engineering Problems in Aviation," by Edwin G. Aldrin, Manager, Aviation Department of the Standard Oil Company of New Jersey. This was most enlightening, telling of the progress being made in the development of power plants, propellers, plane comfort, structures and fuels used in present day aeronautics.

(2) "The Need of Social Mindedness Among Engineers," by Dr. Robert C. Clothier, President of Rutgers University. This was an inspiring address calculated to stir engineering educators from their complacency and content with mere attainment of technical proficiency.

(3) "The Emmet Mercury Vapor Process," by H. N. Hackett, Engineer of the General Electric Company. This paper traced the mercury vapor process from its inception twenty

years ago to the present day, describing, with the aid of lantern slides, the plants being installed at Kearny and Schenectady, in a very interesting manner.

There followed a lively discussion of each of these papers, and on adjournment the members and guests inspected the buildings of the college.

Dinner was served on the thirteenth floor of the Newark and Essex Bank Building, in the dining room of the Down Town Club, at six o'clock, Chairman Disque presiding. President Allan R. Cullimore of the Newark College of Engineering, made a fine address on the subject, "Should Education Lead or Follow Society?" informing the members of the position of his college, one of the youngest engineering colleges in the country, and also presenting for our consideration many points concerning the position of engineering in the educational world as a whole.

Professor H. P. Hammond brought up the matter of complimentary luncheon, which has for several past meetings been served by the host institution, and after some discussion a motion was carried to the effect that the host institution, at all future meetings, be not expected to be put to any expense whatsoever by virtue of the meeting on its campus.

The Committee on Resolutions made the following Report:

The Middle Atlantic Section of the Society for the Promotion of Engineering Education has spent a most profitable and enjoyable day as the guests of the Newark College of Engineering. We have been strongly impressed with the evidences of service to the community, apparent from our inspection of this valuable institution and its work.

Our hospitable reception and the well-planned arrangements and program tendered, have been greatly appreciated. We record our thanks for the delicious luncheon contributed by our hosts, also for the excellent dinner provided amid such delightful surroundings. We express our gratitude to the local committee, to the officers of the college, and to all others who have added to our comfort and enjoyment.

Our thanks are rendered also to the authorities and staffs of the Newark Airport and the Kearny Station of the Public Service Electric and Gas Company, for the privilege of visiting their plants and for courtesies accorded us. We are indebted to Mr. Edwin G. Aldrin, Manager, Aviation Department, Standard Oil Company of New Jersey, and to Mr. H. N. Hackett, Engineer, General Electric Company, for their interesting and instructive papers on recent engineering developments. Especially are we grateful to Dr. Robert C. Clothier, President, Rutgers University, for directing our attention to the present day need for engineers who are socially minded. Finally, we express to President Cullimore our indebtedness for his inspiring exposition of the educational ideals of the Newark College of Engineering, which has so fittingly closed our day's program.

This we beg to submit as the sense of the best attended meeting thus far held by our organization.

(Signed) JAMES S. THOMPSON, McGraw-Hill Book Co.,
S. S. EDMANDS, Pratt Institute.
L. F. WITMER, Lafayette College.

The above resolutions was unanimously adopted.

The Committee on Nominations, consisting of Dean Collins P. Bliss, Professor Hale Sutherland, and Dean Robert L. Spencer of Delaware, Chairman presented its report in the form of the nomination of the following:

For Chairman—Allan R. Cullimore, President, Newark College of Engineering,

Vice-Chairman—Robert C. H. Heck, Rutgers University.

Secretary-Treasurer—Charles G. Thatcher, Swarthmore College.

By unanimous vote of the membership the secretary was instructed to cast a ballot for the above officers and they were declared elected for the ensuing year.

The Committee on Meetings, consisting of Dean J. W. Barker, Columbia, Professor H. P. Hammond, Brooklyn Polytechnic Institute, and Professor P. S. Creager, Rutgers, Chairman, reminded us of the coming meeting in the spring of 1933 at the University of Delaware, and recommended that the annual meeting in the fall of 1933 be held at Cooper Union, New York City. The report was unanimously accepted.

The meeting was adjourned at eight P.M.

(Signed) CHARLES G. THATCHER,
Secretary, Middle Atlantic Section, S. P. E. E.

MACHINE DESIGN CLEARING HOUSE

Discussion of Possible Relationship Between the Density of a Metal and the Value of Poisson's Ratio

"In looking over the values of Poisson's Ratio recently I was struck with their similarity to the weight per cubic inch of the same material.

"For example:

Material	Wt. per Cu. In.	Poisson's Ratio
Cast Iron	.260	.270
Wrot Iron	.277	.278
Steel	.283	.303
Copper	.318	.333
Brass	.300	.333
Lead	.411	.430

"There is probably some relation between the density of a material and its change in volume per unit volume under stress. I have never seen this mentioned before, however, and wondered whether any of the Clearing House members have noticed anything on the subject."—A member of the Clearing House.

"Referring to the question whether a relation exists between density and Poisson's ratio, it seems that the Professor's statements generalize too far. It is true that certain porous materials show low values of Poisson's ratio. This is, for example, the case for concrete or cast iron. However, the low figures for Poisson's ratio are probably not due to the comparatively small density of the material but more to the presence of holes and pores. These latter will close up under compression. Thus the material will show less lateral deformation. But to conclude from this fact that Poisson's ratio must be greater for lead than for steel, is hardly correct. For cast iron Poisson's ratio will probably be variable with stress. For this reason it is not right to record an arbitrarily determined Poisson's ratio for cast iron and to compare it with the ratio for such compact and solid materials as steel or copper. Before anything is more definitely said about the relation between Poisson's ratio and the weight per cubic unit, it would be necessary to check carefully by what testing methods the Poisson's ratios have been obtained for such very differently behaving materials as cast iron and lead."

Commenting upon the Professor's observation concerning the possible relationship between the density of a metal and the value of Poisson's ratio, I submit the following data:

Metal	Opposition %	Density	Weight cu. in.	Poisson's Ratio
1. Electron Metal.....	Mg 94.7, Zn 4.6	1.95	0.068	0.26
2. Duralumin.....	Al 95.5, Cu 3.25	2.80	0.098	0.275
3. Armco Iron, hot rolled.....	Fe 99.5 +	7.88	0.280	0.197
4. Medium Carbon Steel..... Annealed.....	C 0.49%, Mn 0.46 Si 0.12, S 0.029	7.75	0.275	0.241
5. Stainless Steel K A 2.....	Cr 18%, Ni 8%		0.278	0.36–0.365

From these data it would seem that there is no apparent connection between the density and Poisson's ratio. I find no value for Poisson's ratio for such heavy metals as gold or platinum, but it would be apparent that if these were to increase in the order of density they would be considerably in excess for the maximum value of this ratio, which is 0.50.

I think the matter brought up is one that deserves very much more attention than it has received. It is astonishing when you think that what is usually called the very exact mathematical science of elasticity is based upon the use of a constant whose value is so little known. There is almost no data for any of the metals, excepting steel and a few of our better used alloys. Most of this data is a by-product of the tension test and it is questionable whether they may be considered accurate within more than 5 or 10 per cent. Poisson's ratio certainly does have to do with the relation existing between the atomic bounds. It is well known that metals having a large atomic volume are more easily compressible, have a low elastic modulus, high coefficient of expansion, and relatively low melting temperature, while the metals having a small atomic volume have on the whole quite the reverse characteristics. It would seem as though the possibility of connecting Poisson's ratio with other physical data would be one that would be a challenge to the physicist. Apparently the constant is taken much as though it had been handed down engraved on tablets of stone.

REFERENCES

Nos. 1–4. T. McLean Jasper, "Determination of Poisson's Ratio." A. S. T. M., Vol. 29, 1924, Part II, pages 10–12.

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The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

1933 Engineering Drawing Competition.—The Executive Committee of the Division of Engineering Drawing announces herewith regulations governing the annual competition in engineering drawing which will be held in connection with the annual meeting of the Society in Chicago.

1. Drawings must be regular assignments of the first year in an engineering drawing course. (If this first year's course is divided into more than one unit, drawings from any or all of these units are eligible so long as the work is limited to first year engineering drawing courses.)

2. An engineering drawing department may submit one drawing only in each class.

3. Each submitted drawing must have attached to it a statement concerning the following information.

a. The competition class in which the drawing is to be entered.

b. The name, address, and institution of the drawing teacher.

c. The number and length of lecture or class periods, the number and length of drawing room periods, and the number of "home work" periods which were available to the student prior to and including the time spent on the submitted drawing.

d. The number of units of mechanical drawing earned by the student competitor before entering college.

e. The total amount and distribution as above noted of time available for the course.

f. The name and address of the student whose drawing is submitted.

g. A statement of the problem as it was presented to the student.

Classes of Competition.—

Class A. A pencil drawing made with instruments embodying an orthographic shape description only.

Class B. A pencil drawing made with instruments, including both an orthographic shape and size description.

Class C. An inked drawing made with instruments on paper, vellum, or tracing cloth which shall include all the features of a working drawing.

Class D. A freehand pictorial sketch.

Judging.—First, second, and third places will be awarded in each class of competition by a committee of judges to be selected by the Chairman of the Division of Engineering Drawing.

BOOK REVIEWS

A Short Course in Trigonometry, with tables. By JAMES G. HARDY. New York, The Macmillan Company, 1932. ix + 181 pages; tables, xxi + 143 pages. $2.25.

This textbook, according to the preface, is a result of more than thirty years of experience in teaching trigonometry to college students and has been used, in lithotyped form, by a number of instructors for the past three years.

The chapter headings, with a few brief comments, are as follows. I. The Trigonometric Functions. The sine, cosine, and tangent, with some applications, are introduced first; the other functions are then defined as their reciprocals. II. General Definitions. Coördinates and functions of any angle. III. Relations Between the Trigonometric Functions. IV. Reduction to Acute Angles. A simple working rule, using only functions of $180° \pm t$ and $360° - t$, is given. V. Solution of Oblique Triangles. The law of sines and the law of cosines. VI. Variation of the Trigonometric Functions. Line values and graphs. A very good chapter. VII. Radian Measure. Includes a discussion of the cycloid. Another very good chapter. VIII. Functions of Several Angles. IX. Solution of Trigonometric Equations. Inverse Functions. X. Logarithmic Solution of Triangles. Includes articles on force and velocity. XI. Logarithms.

The text is better suited to class room use than to use in a home study course. In introducing new subject matter the author always explains the necessity or desirability of studying such topics—a commendable procedure. The student is carefully warned against a number of the common pitfalls; in particular, he is advised not to memorize results that can be obtained more readily from a suitable figure.

There is an abundance of problems of various degrees of difficulty. Answers are given to most of the odd numbered problems; in the case of problems that are to be solved by the aid of logarithms two answers are given based on the use of four- and five-place tables.

The tables are the *Macmillan Logarithmic and Trigonometric Tables*, edited by E. R. Hedrick. The text is also published separately.

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subject of accuracy of data and significant figures had received more attention.

W. I. M.

Electricity and Magnetism. By NORMAN E. GILBERT. Macmillan and Co., New York. Price $4.50.

This book is intended as a text for a physics course in Electricity and Magnetism to follow the usual first year course. It strikes a happy medium between the usual text of Electrical Engineering and the numerous texts on mathematical theory of electricity. As stated in the preface, "It is the outgrowth of the writer's more than twenty-five years of experience in presenting a survey of the subject as a whole with *physics* in the foreground."

The most striking thing about the book is the free use of practical and modern examples, not only to illustrate principles but to give the student some familiarity with such modern engineering developments as the loaded and phantomned telephone cable and power distribution systems.

Since mathematics beyond the first year of calculus has been eliminated the text may be used as soon as the sophomore year, but it would seem in view of the large quantity of material presented that it would serve better as a text for a principally senior course.

F. L. B., JR.

Modern Physics. By G. E. M. JAUNCEY, Washington University (St. Louis). D. Van Nostrand Co., 1932. Price $4.00.

This book is for use in non-specialized second year courses in physics. The preface states, "The detailed courses in heat, light, electricity and so on are frequently semester courses and a period of two years is generally necessary to cover the ground. However, this program defers the student's contact with such live matters as x-rays, the quantum theory, cosmic rays, relativity, radio, television, astrophysics, geophysical prospecting until his fourth year." It is the purpose of this book to give the second year student a view of these most interesting fields.

The author has had experience in teaching such a course, which shows in the fine arrangement of the book and the simplicity with which some of these rather difficult subjects are handled.

A knowledge of freshman physics and of mathematics, which includes a slight amount of calculus, is assumed, but a chapter on the necessary mathematics is included to cover all deficiencies in this subject.